POWER

Vol. 36 NEW YORK, SEPTEMBER 3, 1912 No. 10

In Convention Assembled

THE National Association of Stationary Engineers will convene in Kansas City and the International Union of Steam Engineers at St. Paul on September 10. These are the two largest organizations of operating engineers in America. Their avowed objects are highly commendable and their possibilities tremendous. Opportunity was never better for advancing the interests of the operating engineer.

On every side is evidence of central-station encroachments on the isolated-plant field. Now is the time for the organizations to launch a vigorous campaign of education for both the engineer and the plant owner. If it were effectively developed, it would be the biggest single thing that could be accomplished.

It is growing more and more difficult to become a thoroughly good engineer because of the increasing complications of plants and the consequent need for greater theoretical knowledge and because the plant owner is continually demanding better service and efficiency.

Developing an adequate educational course for such organizations is not easy, due to the diverse needs of the membership.

First, make the course systematic. Then, arrange it so that each individual's mental equipment, experience, opportunities and aims may be taken into account in modifying the line of study to suit his requirements. The mentally alert and ambitious young man, whose youth allows his spending several years acquiring a thorough fundamental grounding, needs a more elaborate course than the older man. Moral encouragement should be used to the limit of its possibilities. Many a man has given up in despair, not appreciating that he was making progress or not realizing that by perseverance and consistent systematic effort he would win out.

A successful educational campaign can be developed, but it is no easy task. It requires the efforts of men not only versed in the sciences to be taught, but those having a knowledge of human nature as well.

Apparently, then, the educational committee should be selected with especial care and be empowered to develop and put into effect a broad, comprehensive plan of action from which all who can may *Learn More to Earn More!*

Now turn to the "Moments with the Ad Editor," at the end of the text pages. It deserves the careful consideration of every man in the organizations.

If you agree with the doctrines set forth, dig in, tooth and nail, for their accomplishment. It's new thought, and we believe you will be glad you read it.

Impulse and Reaction Turbines

By F. R. Low

While the difference between an impulse and a reaction turbine is very apparent in the elementary machine, it is not as easily seen in the complex turbines as now made. The article points out the essential difference, with a simple explanation of the application of the velocity diagram to each.

What is the difference between an impulse and a reaction turbine?

This difference is easily seen when the elementary machines like the single-rotor DeLaval, Fig. 1, and the Hero or Avery turbine, Fig. 2, are considered, but is not so apparent in the multi-stage form which the commercial turbine has taken.

Compare the Rateau and Parsons types for example, the first an impulse, the second a reaction turbine. Each consists of alternate rings of stationary and movable blades, Figs. 3 and 4. In each the steam is expanded in the stationary blade passages, enters the passages between the moving blades, and leaves these blades with its velocity absorbed, or greatly reduced, having given up to the revolving member the energy lost by the reduction in its velocity. By further expansion in the next row of stationary blade passages, the velocity is again generated, to be again absorbed in the next row of rotating blades.

Where, then, is the difference, and wherein does it consist that the action is in one case that of impulse and in the other of reaction? Perhaps the difference can be best shown by tracing the action in each case.

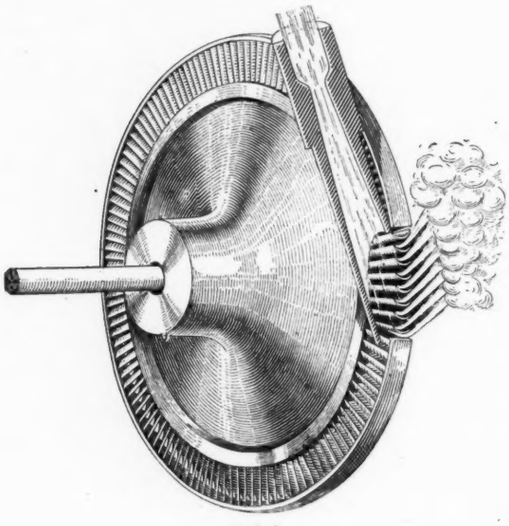


FIG. 1.

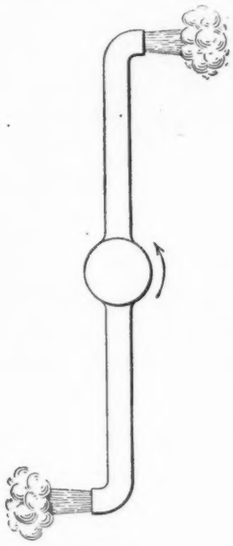
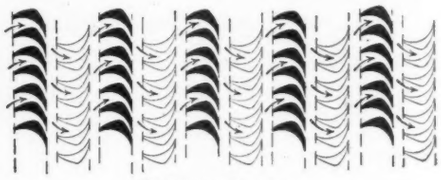
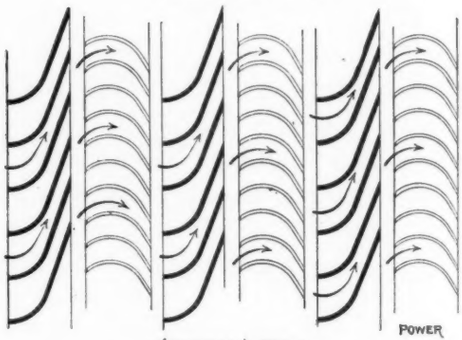


FIG. 2



(PARSONS) FIG. 3.



(RATEAU) FIG. 4.

In Fig. 5, steam is expanded in the nozzle so that the jet issues with a velocity of 1000 ft. per second. To get out of this jet the energy which has been expended in setting it in motion it must be brought to rest relatively to the nozzle. If the blade is moving with a velocity equal to that of the steam, the latter will move along with it and lose none of its velocity. If the blade is stationary, the jet will simply be turned around upon it and, friction neglected, pass off with the same velocity at which it entered the blade, but in the reverse direction. But if the blade is moving with half the velocity of the jet the jet will approach and impinge upon the blade with a velocity of 1000 — 500 = 500 ft. per second, and will flow backward from the discharge edge of the blade with the same velocity, *relatively to the blade*. But, since the blade is going forward at the rate of 500 ft. per second, and the steam is flowing backward at the same velocity relatively to it, the velocity of the steam, relatively to the nozzle, will be zero. It will have been brought to rest, and the energy due to its velocity transferred to the blade.

If the line *AC*, Fig. 5, represents the velocity of the jet as it leaves the nozzle and the line *BC* the velocity of the bucket, then the difference, *AB*, will represent the relative velocity. On the discharge side the jet comes off with the same velocity, *A'B'*, backward, and the difference, or algebraic sum of its velocity, *A'B'*, in this direction, and its forward velocity, *B'C'*, in the blade, is zero.

In the turbine it is difficult to completely reverse the direction, and the nozzle, or guide blade passages, usually lead in at an angle. Suppose the velocity and direction of the steam as it leaves the nozzle to be represented by *AC*, Fig. 6. Its velocity and direction relatively to the blade, will be represented by *AB* where, as before, *BC* represents the direction and velocity of the blade. The blade is made of such a shape that the steam will enter smoothly at this angle, and if the blade is symmetrical, the jet will issue at the same angle relatively to the blade, and (still neglecting friction) with the same relative velocity, *A'B'*. Laying out the blade velocity *B'C'*, it is seen that the only velocity left is that proportional to *A'C'* in the direction of the axis of the turbine. By varying the speed of the jet, that of the blade, and the angles of entry and exit, these component velocities may be varied all sorts of ways in magnitude and direction.

A turbine constructed in this way with no expansion of the steam in the moving blade passages, acting simply by the impulse of the steam upon those blades, by the effort which the steam exerts upon them when its direction of flow is deflected, is an impulse turbine.

When one wants to board a moving car he runs until he is moving as fast as the car. His velocity relatively to the car is then zero and he can board without shock, just as though both he and the car were standing still.

In the impulse turbine the steam is expanded in the stationary nozzles, or blade passages, until it has a velocity more than twice that of the blades. In the reaction turbine of the Parsons type it is expanded in the stationary blade passages (for the abstract case) until it has a velocity equal to that of the moving blades, just so that it can get aboard

comfortably. In the passages of the moving blades, however, and here is the essential difference, it is expanded until it has a velocity in the blade equal to the forward velocity of the blade itself.

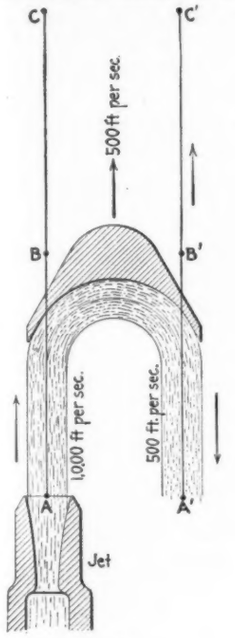


FIG. 5

In Fig. 7 a car is paying out rope which simply lies quietly upon the ground as it is left by the car. The rope is issuing from the eyelet with the *same* velocity that the car moves forward *relatively to the car,* but that which has issued with this velocity has no motion relatively to the ground. In the same way the steam jet issuing backward from the moving blades with a velocity equal to their forward motion, is brought to rest with reference to the casing, and has given up its energy to the revolving member.

In Fig. 8, *AB* represents the velocity and direction with which the jet issues from the stationary guide passages, *CB* the velocity and direction of the blades. The direction and velocity of the jet,

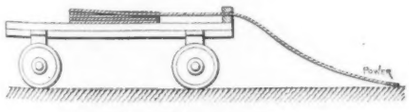


FIG. 7

relatively to the moving blades, will then be represented by *AC*. The steam simply flows, without impact or shock, into the passages as they go by, having the same amount of forward motion or velocity as the blades. It would now simply stay in the wheel and be carried around with it indefinitely, but the pressure on the delivery side of the blades is less than that on the entry side, and the steam expands in the passages between the moving blades enough so that the velocity, *A'B'*, with which it issues, is such that its component, *B'C'*, in the direction of the blade's motion, shall be equal to the blade velocity. The resultant relative motion is represented by A_1C', with a velocity proportional to which the steam flows into the stationary nozzles to be expanded again until its velocity,

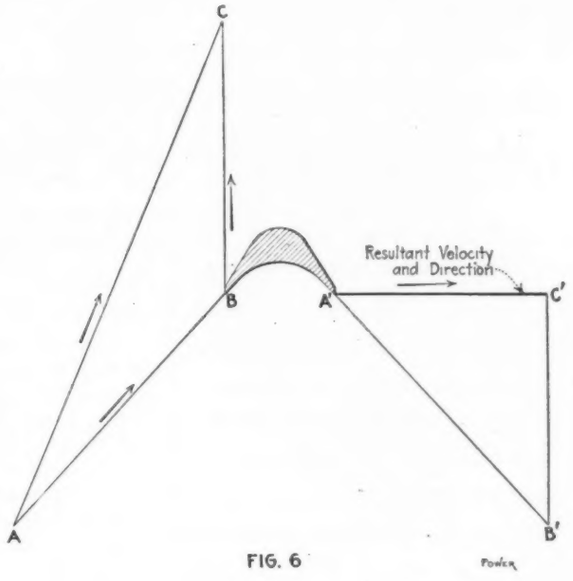


FIG. 6

in the direction in which they are moving, equals that of the blades.

The passages between the blades, notwithstanding the steam is expanded in them, grow smaller in the direction of flow, that is, they form converging nozzles. This is because the increased velocity allows the steam to pass through a

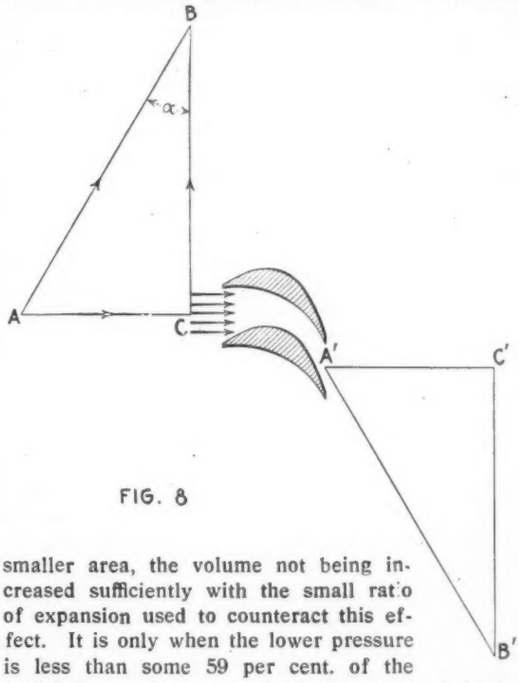


FIG. 8

smaller area, the volume not being increased sufficiently with the small ratio of expansion used to counteract this effect. It is only when the lower pressure is less than some 59 per cent. of the initial that a divergent nozzle like that of DeLaval is needed, and this is convergent at the entering end.

In the ideal case above considered, the blade velocity *CB*, Fig. 8, must be pretty nearly that of the jet *AB* (0.94 for an angle at α of 20 deg.) This means either a very high blade velocity, or a low steam velocity. The blade velocity is fixed by the speed at which the turbine is to run and a practical diameter. Only a certain amount of steam passage can be allowed in the initial stationary row to admit the quantity of steam required to run the load for which the turbine is designed, and if the diameter is made too large, the blades of the first rows will have to be made so short that the clearance will be excessive in proportion to their projected area. There is therefore a limit to blade velocity. On the other hand, keeping the jet velocity down means a small expansion at each stage, and hence a large increase in the number of stages. The designer is therefore compelled by constructional and commercial considerations to use steam velocities, the components of which, in the direction of the blade movement, exceed the blade velocity, which produces the condition illustrated in Fig. 9. The resultant direction of flow is not axial. The steam enters the blade passage with a velocity proportional to, and in the direction represented by, *AC* and thus exerts an impulse in the direction of rotation. The steam then expands in the moving passages and operates by reaction, as before explained. This impulse effect is usually, if not always, present in the Parsons machine, and when it is involved, the machine is to that extent a combined impulse and reaction turbine, the reaction feature, however, predominating. With high-speed turbines as they are being

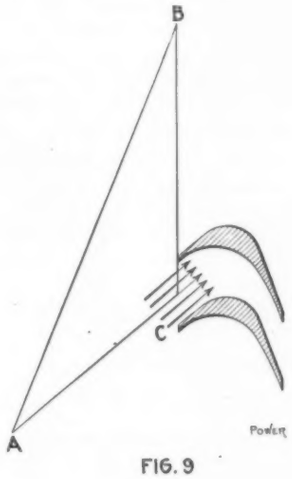


FIG. 9

built today the ideal condition is closely approximated.

The moving blades of the impulse turbine run in a chamber the pressure in which is essentially the same throughout. When the blades are carried upon disks

the latter usually are perforated to maintain equal pressure on the two sides of the disk. With the reaction type, the pressure at the entry side of the blades is greater than at the delivery side, and this difference for each stage, produces in the aggregate, a heavy end thrust which must be taken up by balancing, or dummy pistons.

The Parsons is a "full-admission" turbine, that is, the first row of stationary, or guide blades, occupies the full circumference, and the whole circle, except such part of it as is filled by the blades themselves, is available for admitting steam. The first rows of blades are mounted upon a drum of small diameter so that the blades may have a fair height without making this opening too large, and a large number of rows are used so that the pressure fall may be small in each stage, and the velocity kept down. As the volume of steam gets larger, larger drums and fewer stages are used. In the impulse type the diameters of the rotors are the same throughout.

Flue Gas Analysis for Beginners—I

By J. E. Terman

In simple language, the author explains the object of flue-gas analysis and the principle of operation, describes the apparatus necessary and tells how to prepare chemicals.

Many writers on flue-gas analysis for beginners commence by impressing the reader with its extreme simplicity. They often imply that the manipulator of the analyzing apparatus need not be familiar with chemistry to make successful volumetric determinations of the four principal gases in the products of combustion, viz., nitrogen, carbon dioxide, oxygen and carbon monoxide. Perhaps this attitude is due to their being so expert themselves that to them it is simple. Therein they are at a disadvantage in instructing the beginner; they have forgotten the little perplexities that arose when they were beginners themselves and fail to mention them.

In what follows the writer is relating his experience and describing methods adopted to overcome difficulties encountered after a comparatively short time in dealing with the subject; hence there may be many better ways to do certain things than here related.

Familiarity with the manipulation of the Orsat apparatus and the mixing of reagents was obtained by studying an excellent little book entitled "Gas and Fuel Analysis for Engineers," by Prof. Augustus H. Gill; this book is recommended to all beginners. The only analyzing apparatus used is the ordinary three-pipette Orsat, with the reagents described by Prof. Gill for determining carbon dioxide, oxygen and carbon monoxide. Hereafter for brevity, the four gases nitrogen (N), carbon dioxide (CO_2), oxygen (O) and carbon monoxide (CO), will be referred to by their chemical symbols.

Object of Flue Gas Analysis

Most engineers interested will understand the object in making flue-gas analysis and what the results obtained indicate. Knowing the flue-gas composition shows how the coal was burned, because in good boiler practice all of the coal, except that remaining as ash or clinker, passes up the stack as gas, fine ashes, or soot, mixed with about 18 times its weight of air. The burning of coal is the combination of the larger part of its constituents with oxygen from the air.

A low flue-gas temperature does not prove that all the heat has been extracted from the fuel for two reasons: First, the air taken in under the grate to support combustion carries away a certain amount of heat depending on the temperature difference between the air and the stack. Under best conditions from 12 to 15 per cent. of the heat of the fuel is so lost; hence if more air is passed through the furnace than is required for complete combustion (and frequently two or three times this amount is used) considerable heat is wasted, even though it gives a lower stack temperature. Second, the carbon of the coal, the chief heat producer, can combine with oxygen either as CO or CO_2. With plenty of oxygen and a suitable temperature CO_2 will be formed; otherwise CO. Carbon burned to CO gives only about one-third the heat produced when burned to CO_2, so low stack temperature if due to prevalence of CO does not mean economy. Escaping CO takes with it two-thirds of the heat in the coal from which it came.

A thin bed of fuel, although making an intensely hot fire, is not economical, as an Orsat will show, for the heat developed is largely expended in heating excess air instead of evaporating water. An ordinary evaporative test does not separate the furnace performance from the heat-absorbing capacity of the boiler, but a flue-gas analysis is needed to locate the trouble, if the evaporation per pound of fuel is not what it should be. It tells whether the heat in the coal has been fully utilized in the furnace and, by varying the way of firing, will show whether the fireman or the furnace is responsible for the poor results. A boiler should not be charged with the shortcomings of the fireman, or furnace, unless it is such that it cannot be equipped with a suitable furnace to burn the fuel for which it was designed.

Principle of Volumetric Gas Analysis

The volumetric analysis of gas with the Orsat apparatus consists of absorbing successively three of the four principal gases found in the products of combustion. After each is absorbed from a measured sample, the decrease of volume is measured. A strong solution of caustic potash, given sufficient time in contact with the sample, will absorb all of the CO_2, leaving only O, CO and N. This passed through potassium pyrogallate, a caustic potash solution with pyrogallic acid added, loses its O, leaving only CO and N. Finally a solution known as acid cuprous chloride will absorb the CO, leaving only N.

As potassium pyrogallate will absorb CO_2 as readily as O, the CO_2 separation must be made first through the caustic potash solution. Similarly the acid cuprous chloride solution will absorb both CO_2 and O as well as CO, hence this reagent must be used last.

Apparatus

The Orsat apparatus may be obtained from any dealer in chemical supplies and apparatus. The cost complete, including

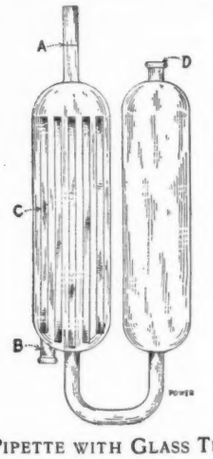


Fig. 1. Pipette with Glass Tubes in Place

chemicals and sampling apparatus, is about $30. Compared with an indicator outfit, it is cheap and, if intelligently used, the chance for saving coal is several times

that for the indicator in the average plant. Before assembling a new apparatus all parts should be thoroughly washed.

Fig. 1 shows a side view of a pipette with the front leg filled with short lengths of glass tubing *C*, the purpose of which will be explained later; there are three of these pipettes to the apparatus, as may be seen in Fig. 2.

In Fig. 1, *A* is the end to be connected with one of the branches from the main connecting pipe which terminates at *H* in Fig. 2, the other end is connected to the measuring burette at *I*. Each of the three branches from this main connecting pipe has a glass stop-cock *N* to control the connection between each pipette and the burette. The glass ends of the pipettes and the branches for the main connecting pipe are connected by 2-in. pieces of thick rubber tubing, as at *A*, Fig. 1.

By moistening the glass ends the tubing will slip on easily with less danger

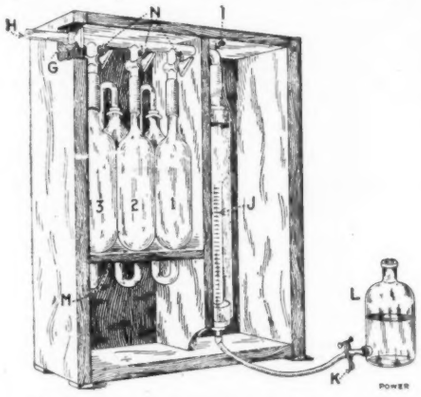


FIG. 2. ORSAT APPARATUS ASSEMBLED

of breaking the apparatus. Prof. Gill and some others recommend pinch cocks on the rubber tubing, instead of the glass stop-cocks, because the latter tend to stick. The writer uses glass cocks without any trouble from sticking by preventing reagents from running through them, and lubricating them with a very little vaseline, spread on each plug with the finger. Too much vaseline is likely to stop up the passages through the connections or the plug.

Enough short lengths of glass tubing to fill the three pipettes come with the apparatus; these should be inserted in the connection *B*, Fig. 1. One set of these tubes will contain small spirals of copper wire; these should be put in the pipette used to determine CO, No. 2 in Fig. 2. The glass tubing gives more surface for the reagent to spread over and breaks up the gas into thin layers so that the chemical reaction may be more rapid and complete.

After inserting the glass tubes in the pipettes and connecting up and placing them in the wooden frame, as in Fig. 2, the burette *J* should be connected to the right end of the main connecting pipe with rubber tubing. The burette should be thoroughly washed out beforehand and the annular space between the outer casing and the measuring tube should be filled with water to prevent, as far as possible, any change in temperature of the sample while being analyzed, as such a change would affect its volume.

The apparatus, completely assembled in Fig. 2, is ready to receive the reagents. The balance of the laboratory equipment, such as the measuring glass and bottles for holding the surplus supply of reagents, is as follows: Two bottles of 500 c.c. capacity each are used to hold a supply of dilute hydrochloric acid, and should be labeled "HCI sp.gr. 1.10," a 1000-c.c. bottle should be labeled "Potassium Hydrate" and a 500-c.c. bottle "Acid Cuprous Chloride." Four bottles, with necks on the side near the bottom, similar to the one in Fig. 4, are used, as described later, for collecting gas samples. A 500-c.c. graduate, for measuring, and a 3-in. glass funnel complete the outfit.

CHEMICALS REQUIRED FOR REAGENTS

The chemicals and materials for making the reagents and the best amount

CO_2	O	CO
11	8	0.1
12	5	1.0
13	7	0.5

FIG. 3. RECORD FOR DETERMINING CONDITION OF REAGENTS

to purchase of each are: hydrochloric acid (commercially pure), a 6-lb. bottle holding about 5 pints; black copper oxide, 1-lb. bottle; pure copper in the form of wire, about 1 lb. of No. 10 gage; potassium hydrate, which comes in sticks, a 1-lb. bottle (that purified by lime is superior to that purified by alcohol for gas analysis); pyrogallic acid in fine white crystal form which is extensively used in photographic work, a ½-lb. can.

MIXING REAGENTS

The reagent for the first pipette, No. 1 in Fig. 2, for determining CO, is made by dissolving potassium hydrate in water; the entire pound may be dissolved at once in about 900 c.c. of distilled water and kept in the stock bottle for use as required. As considerable heat is evolved in dissolving potassium hydrate in water, the bottle should be placed where, if it breaks, the contents can do no damage.

The potassium pyrogallate for the second pipette should be made up only as needed since its affinity for oxygen makes it spoil quickly by contact with air; it is therefore most satisfactory to make it directly in the pipette by adding 5 grams of pyrogallic acid to 100 c.c. of the potassium-hydrate solution, or like proportion, according to the capacity of the pipette. When the arm of the pipette containing the glass tubing is filled to the line on the neck, the rear leg of the pipette should be almost empty, say, about ½ in. above the level of the frame *M*, Fig. 2, supporting the pipettes.

The pyrogallic acid may be placed in the pipette through the opening *D*, Fig. 1, but this is laborious and the solution will be nearly as well protected from the air by placing the pyrogallic acid in the glass funnel and pouring the solution of potassium hydrate over it. The acid dissolves almost instantly and is carried through the funnel into the pipette in solution. It is not necessary to weigh the acid after becoming accustomed to mixing it, for a quantity can be gaged with sufficient accuracy with the eye. While pouring the solution into the rear leg of the pipette the stop-cock *N*, Fig. 2, controlling the connection from the pipette to the main connecting pipe, should be opened. As soon as the solution has been put in, close the cock and place the rubber bag, which comes with

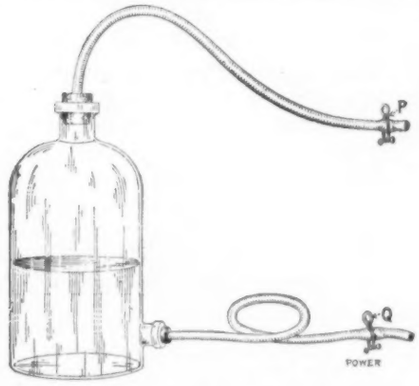


FIG. 4. BOTTLE FOR COLLECTING GAS SAMPLE

the apparatus for this purpose, over the connection *D*, Fig. 1, to prevent access of air to the reagent.

Hydrochloric acid, specific gravity 1.10, is made by diluting the commercially pure acid with an equal volume of distilled water. Enough should be mixed to fill the two 500-c.c. bottles labeled for this purpose. This dilute acid is of frequent use for neutralizing potassium hydrate that is accidently spilled. This acid is also used for making the acid cuprous chloride for determining CO. It is the most difficult reagent to prepare and the least satisfactory in its action. Prof. Gill gives the following directions for making it:

Use the 500-c.c. bottle for mixing and

place enough of the black copper oxide in it to cover the bottom about ½ in. deep; then put in eight or ten pieces of the No. 10 copper wire cut long enough to reach from the bottom of the bottle to the neck. Pour in dilute hydrochloric acid until the bottle is full, then cork tightly with a rubber stopper to keep the air out. The bottle should be well shaken and placed where warm, to hasten the chemical action. When first mixed, this reagent is a very dark brown, but after 10 days, or more, will probably clear up and the bottom of the bottle contain small while crystals with the remaining black copper oxide. The correct quantity of this clear liquid can be poured into pipette No. 3, which contains the tubes with the spirals of copper wire.

The Orsat apparatus is now ready for use. The stock bottle in which the acid cuprous chloride is prepared should be filled at once with the diluted hydrochloric acid, and it is ready for further use when occasion requires. When the acid cuprous chloride does not become clear, it is due to air reaching it, which turns it brown. This is difficult to prevent, but because the solution is dark, does not detract from its quality, if the white crystals are noticed, for their presence indicates that the solution is saturated and ready for use. This reagent is not very satisfactory on account of its weak attraction for carbon monoxide, which it is used to dissolve.

Absorption Capacities of Reagents

Each of the reagents has a limited capacity; that is, becomes worn out after it has dissolved a certain amount of gas. Therefore the different quantities of the various gases analyzed should be noted to know when the reagents should be renewed. For this purpose a small pad may be fastened to the side of the Orsat frame and the number of cubic centimeters of each gas analyzed entered on it. There should be three headings on this pad and the amounts put down, as shown in Fig. 3, so that they may be added up at any time.

Potassium hydrate will absorb 40 times its own volume of gas before becoming too weak for use. A pipette holding 150 c.c. of this solution should absorb 6000 c.c. of CO_2 before needing renewal.

Potassium pyrogallate is not nearly so active, as only twice its volume of oxygen may be absorbed before a new solution is required.

According to Prof. Gill, acid cuprous chloride has an absorption capacity, with the Orsat apparatus, of only one, that is, 150 c.c. of the reagent will absorb only 150 c.c. of CO before renewal is required. Other authorities give it considerably greater capacity than this, but as the reagent is very cheap and, at best, is unsatisfactory, the writer would recommend that no more gas than that equal to the volume of the reagent be dissolved in it before using a new solution. On account of the extremely large capacity of the reagent for CO_2, as compared with the others, it is not necessary to keep a record of the amounts of this gas analyzed, for it is only necessary to renew this solution once to every eight, or ten, renewals of the potassium pyrogallate.

Nordberg Variable Capacity Power Pump

The Nordberg Manufacturing Co., Milwaukee, Wis., has developed a variable-capacity power pump which affords simplicity of control and close regulation of output. The length of stroke is variable and the water end of any type of reciprocating pump may be used.

Power is applied to the shaft *A*, Fig. 1, and is transmitted through the reducing gears *B* and *C* to the shaft *D* and crank *E*, connected to the pin *F* by the rod G. The pin *F* ties the ends of the rods *G*, *H* and *I* together, as shown. The rod *I* is hinged on the pin *J* which is secured to the casting *K*. Rotating the crankpin *L* causes the pin *F* to swing in an arc, with the pin *J* as a center. The crosshead *M* reciprocates horizontally between its guides a distance depending upon the position of the arc described by the pin *F*.

The casting *K* is hinged to the side frames of the machine and rotates about *N* as a center and the pin *J* may be turned to any point in an arc about the center *N*. The radius of the arc is such that by rotating the casting *K* sufficiently in a counter-clockwise direction from its position shown, the center line of the pin *J* will coincide with the center line of the

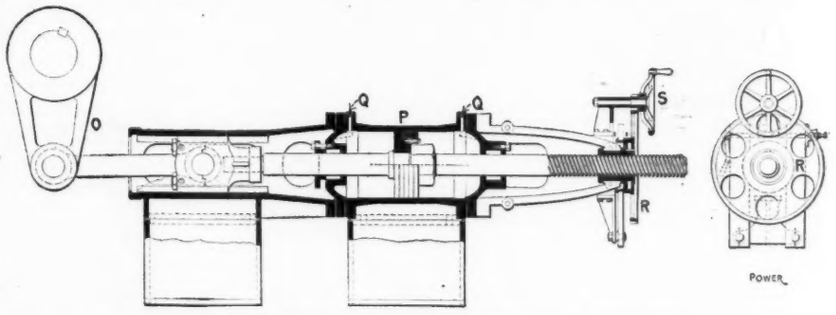


Fig. 2. Details of the Adjusting Mechanism

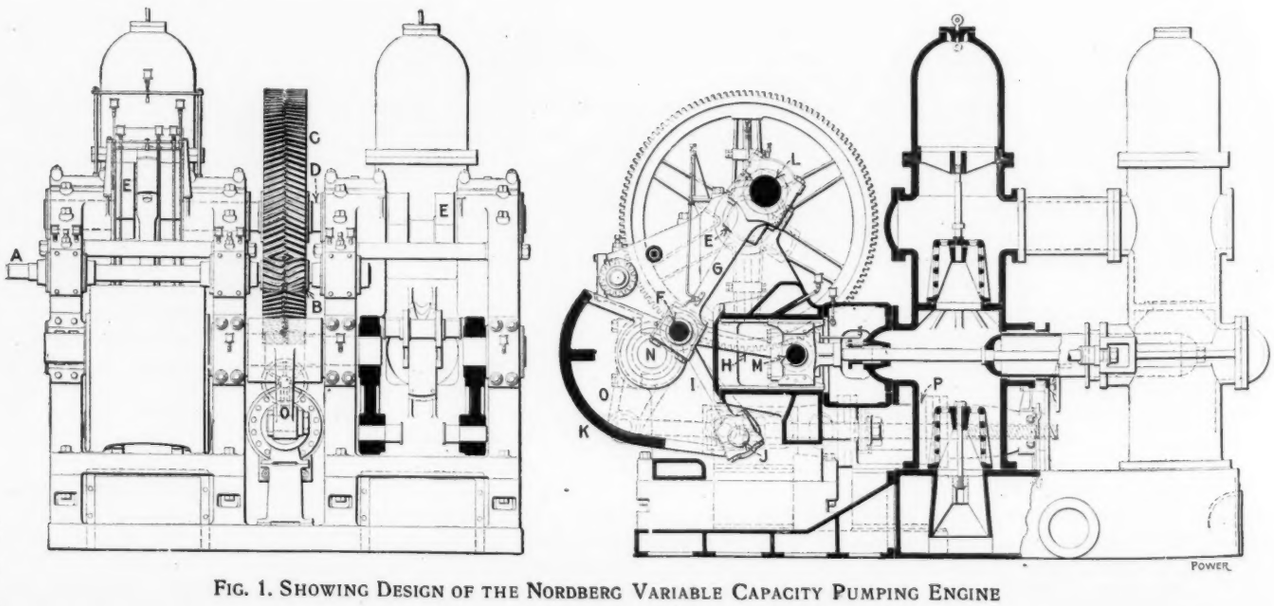


Fig. 1. Showing Design of the Nordberg Variable Capacity Pumping Engine

crosshead pin at *M* when the latter is at the extreme end of the out stroke. The rods *H* and *I* are the same length and when the center lines of *J* and *M* coincide, the pin *F* swinging about *J* as a center produces no motion of the crosshead *M*. By adjusting the position of *J* any length of stroke from zero to the maximum may be obtained.

The position of the casting *K* is adjusted by the arm *O* which is connected to the piston in the hydraulic cylinder *P*. This piston may be operated automatically, by a float in the discharge reservoir, a pressure-controlled pilot valve, etc., or it may be controlled by hand as in the present case. Fig. 2 shows the construction details of the hydraulic cylinder *P* and the connections with the arm *O*.

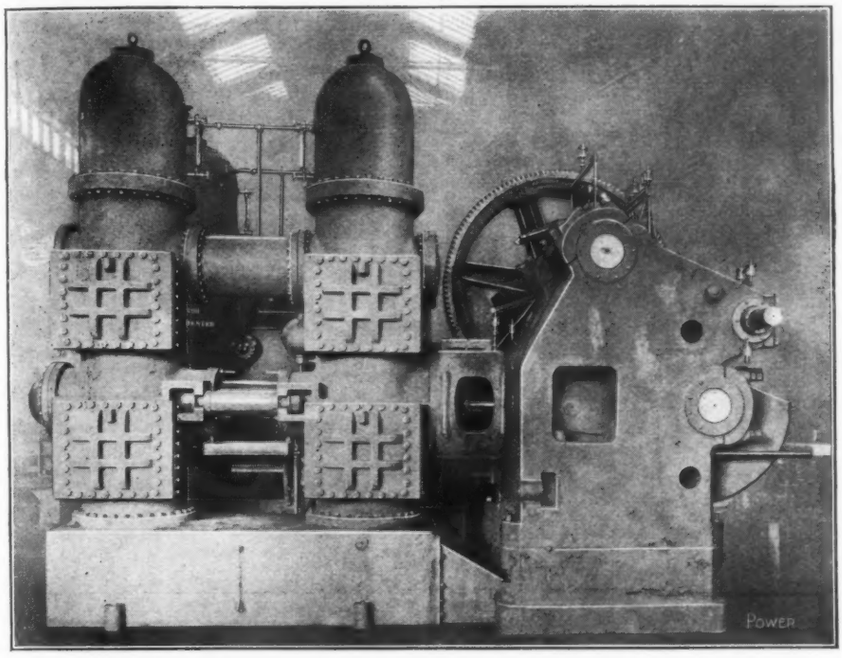


FIG. 3. SIDE VIEW OF ROCHESTER PUMP

The pump shown in Figs. 3, 4 and 5 has a capacity of 6,000,000 gal. per 24 hr. when operating at full stroke, 18 in. The plungers are 16⅛ in. in diameter and the speed is 67 r.p.m. The pump works against a static head of 530 ft.

The piston in the hydraulic cylinder *P*, Figs. 1 and 2, is operated by water pressure through a four-way valve communicating with the ports *Q*, Fig. 2. An adjusting rod attached to the piston extends through the end of the cylinder and has high-pitch screw threads cut in its outer end. A wormwheel *R*, controlled by a handwheel *S*, rides on this screw and acts as a brake to prevent the piston from moving except when operated by the handwheel.

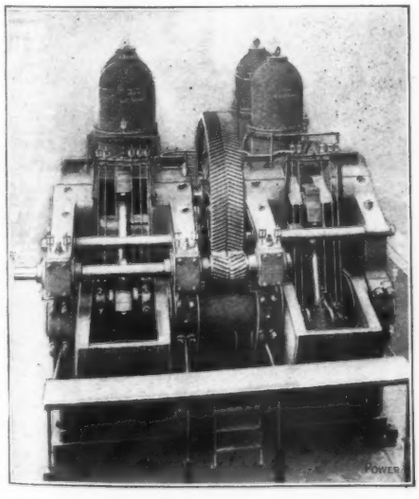


FIG. 4. END VIEW, SHOWING DRIVING MECHANISM

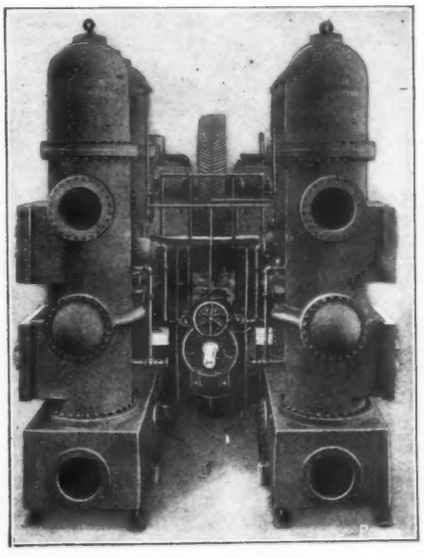


FIG. 5. VIEW SHOWING CONTROL WHEEL

The output of the pump is changed by adjusting the four-way valve to admit water pressure to the proper end of the cylinder and exhaust it from the other; the handwheel is then turned to allow the piston to move in the desired direction. A 600-hp., three-phase, 60-cycle, synchronous motor running at 500 r.p.m., will run the pump. Although directly connected, the motor may be started light and the load applied as slowly as desired,

The reducing gears are of the Wuest staggered herring-bone machine-cut type, and are noiseless.

Simple CO_2 Meter

A simple apparatus for measuring CO_2 is shown in the accompanying engraving, reproduced from our German contemporary, the *Berliner Tageblatts*. The lower globe is filled with the absorbing liquid, 260 grams of caustic soda in one liter of water, and the opening just above it is completely closed with a rubber cork. One filling will suffice for some 200 samplings.

A SIMPLE CO_2 METER

When the apparatus is to be used, the rubber cork is removed and replaced with the cock *A*. The apparatus is then drawn full of the gas to be tested, the upper cock *B* closed, and the under cock *A* turned to place the absorbent in communication with the gas. The apparatus is inverted so that the alkali solution will run into the gas-holding chamber, and, after the gas is thoroughly absorbed, is again placed in the position shown in the engraving so that the liquid will return to the lower globe. The cock *A* is then closed, the whole apparatus placed under water, and the cock *B* opened when water will enter through the opening *C* to replace the gas absorbed by the liquid.

The apparatus should now be held upright with the opening *C* still under water until no more water will run into it,

when the level of the liquid inside is the same as that upon the outside. Then the cock *B* should be closed, the apparatus returned to the position shown in the engraving, the cock *B* opened to allow the water in the neck *C* to pass to the interior, and the level of the water upon the graduated scale will indicate the percentage of CO_2.

Laying Out Power Plant Piping

By J. P. Lisk

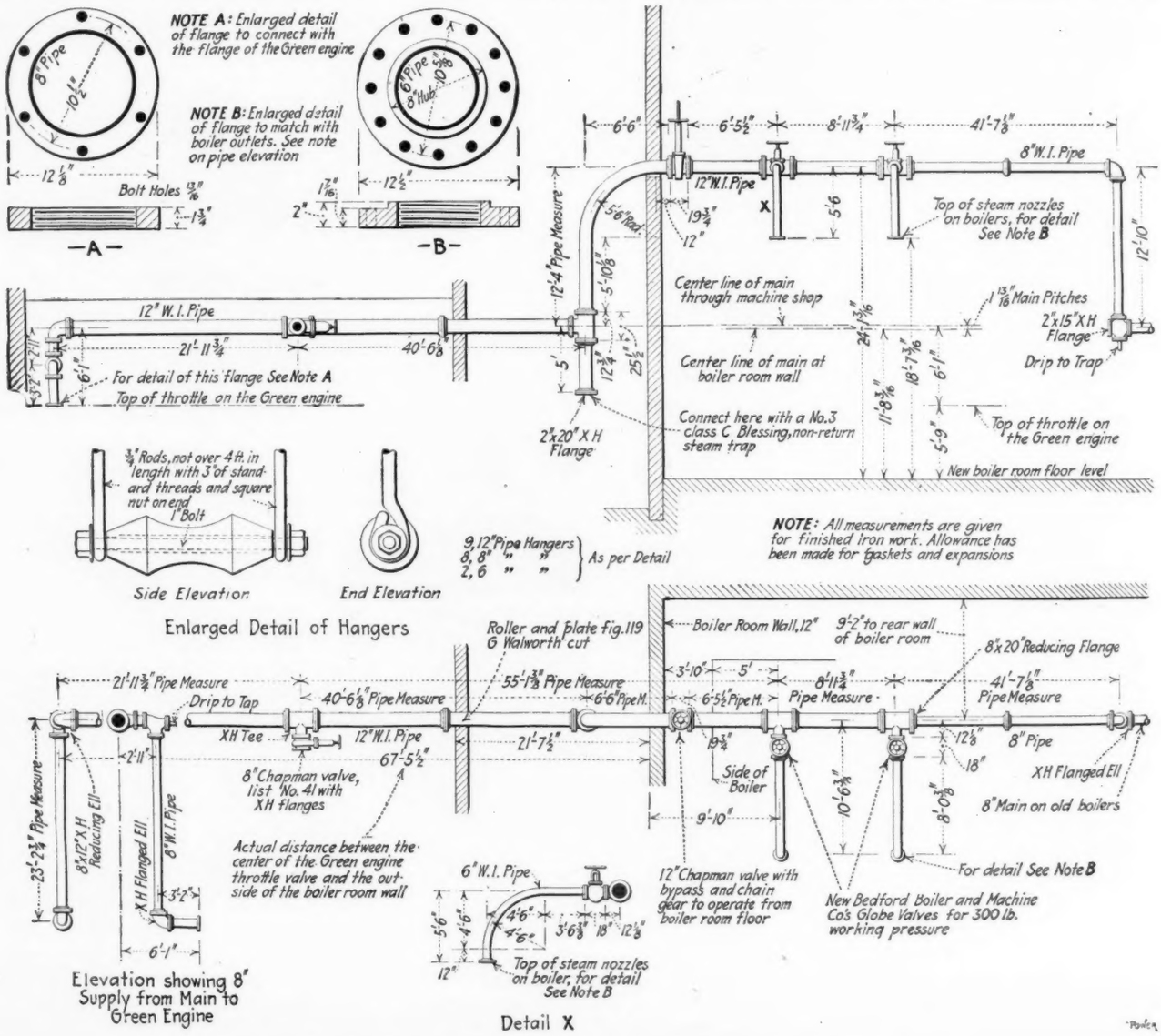
A simple illustration from a practical engineer showing what measurements to take and how an accurate plan can be made intelligible to an ordinary workman.

When an engineer is called upon to lay out the piping system for a power plant he should have in mind, first, safety; second, efficiency; third, durability. Extravagance and excessive economy are to be avoided, as either, if carried to the extreme, paves the way for disastrous results. High fixed charges result in excessive cost of production, and too much economy brings about the same result in excessive repair bills, with the added possibility of wrecking the plant and causing loss of life.

Starting with the maximum pressure, the engineer makes his calculations and specifies plainly just the kind of material and fixtures to be used, giving size, capacity and some make as a standard that shall be accepted, or one of equal make subject to approval. Methods of attachment and support and every part of the work must be so fully described that a mistake in carrying out his intention is practically impossible.

After the specification is written, the plan is made, and with the specification and free-hand sketches made by the engineer when working out his calculations, it is an easy matter for the draftsman.

In making plans it is essential to include and dimension accurately all that part of the building within which the apparatus and piping is to be placed. Everything must be made perfectly clear, even if it does take considerable paper


NOTE A: Enlarged detail of flange to connect with the flange of the Green engine
NOTE B: Enlarged detail of flange to match with boiler outlets. See note on pipe elevation
8" Pipe
10½"
12⅛"
Bolt Holes 13/16"
1¾"
6" Pipe
8" Hub
10⅝"
12½"
1 7/16"
2"
-A-
-B-
6'-6"
6'-5½"
8'-11¾"
41'-7⅛"
8" W.I. Pipe
12" W.I. Pipe
19¾"
12"
5'-6"
Top of steam nozzles on boilers, for detail See Note B
12'-10"
12'-4" Pipe Measure
5'-10⅜"
Center line of main through machine shop
1 13/16" Main Pitches
2" x 15" X H Flange
Drip to Trap
Center line of main at boiler room wall
Top of throttle on the Green engine
New boiler room floor level
12" W.I. Pipe
21'-11¾"
40'-6⅛"
For detail of this Flange See Note A
Top of throttle on the Green engine
2" x 20" X H Flange
Connect here with a No. 3 class C Blessing, non-return steam trap
¾" Rods, not over 4 ft. in length with 3" of standard threads and square nut on end
1" Bolt
Side Elevation
End Elevation
9, 12" Pipe Hangers
8, 8" " "
2, 6 " " "
As per Detail
Enlarged Detail of Hangers
NOTE: All measurements are given for finished iron work. Allowance has been made for gaskets and expansions
Roller and plate fig. 119 G Walworth cut
Boiler Room Wall, 12"
9'-2" to rear wall of boiler room
8" x 20" Reducing Flange
21'-11¾" Pipe Measure
Drip to Tap
40'-6⅛" Pipe Measure
55'-1⅜" Pipe Measure
6'-6" Pipe M.
6'-5½" Pipe M.
Pipe Measure
41'-7⅛" Pipe Measure
XH Tee
12" W.I. Pipe
21'-7½"
67'-5½"
8" Chapman valve, list No. 41 with XH flanges
Actual distance between the center of the Green engine throttle valve and the outside of the boiler room wall
Side of Boiler
9'-10"
12⅛"
8" Pipe
18"
XH Flanged Ell
8" Main on old boilers
For detail See Note B
12" Chapman valve with bypass and chain gear to operate from boiler room floor
New Bedford Boiler and Machine Co's Globe Valves for 300 lb. working pressure
23'-2¾" Pipe Measure
8½" x 12" X H Reducing Ell
8" W.I. Pipe
XH Flanged Ell
3½"
6'-1"
Elevation showing 8" Supply from Main to Green Engine
6" W.I. Pipe
4'-6"
3'-6⅜"
18"
12⅛"
12"
Top of steam nozzles on boiler, for detail See Note B
Detail X
Power

WORKING DRAWING FOR SMALL PLANT, GIVING NECESSARY DIMENSIONS AND NOTES

and tracing cloth, and it is important not to make the sheets too large. It is much better to have several that may be conveniently handled than one large sheet that must be folded or laid on the floor to be read. From experience in the field the author can testify that making up a list of material and getting dimensions from a 36x48-in. blueprint is very annoying work. Prints, 24x30 in., outside measure, are the largest that should be made. If the plant is large and complicated, a small scale drawing should be made, showing the location of the various apparatus and piping, and then one-quarter section sheets to a larger scale, and details to a still larger scale. Following this order the writer has made excellent plans of a complete plant of large size, and all on a uniform sheet 18x24 in.

Always should be given the center-line measurements of the apparatus to be installed, the distance from the walls of the building, the distance between machines and the heights to the various outlets.

The piping layout being about the last thing to be put on the plan, is usually made in a hurry, and the draftsman often does not hesitate, when he meets with some apparent obstruction, to dodge it with a bend or go around it with fittings and short pieces, where perhaps some slight change further back in the line would give a perfectly straight run.

After the fixtures are all properly located with plenty of room around each to operate, clean and repair, the engineer should run his pipes to and away from each fixture in such a way that all valves and parts of the apparatus may be easily reached, and not conflict with the operation or repair of the apparatus to which they are attached. All of these branch lines should be carried up or down, as the case may be, and then the main lines laid out, which are of comparatively large size, so that all unnecessary turns may be avoided, even at the expense of making the branch lines longer and larger than would be necessary if the main was brought nearer to the fixture. Finally, one should look carefully into the details of support; this should not be left to the judgment of the steamfitter. It is not sufficient to mention in the specification that a suitable hanger shall be placed at intervals of 10 ft. on all lines of pipe, or a pipe chair with roller where such an arrangement is convenient. Where several extra-heavy fittings and valves are located in a 12-in. line, the weight to be supported runs up, and in view of the vibration, in addition to the dead weight, the problem of putting it up to stay deserves attention.

The accompanying drawing is an illustration of a high-class job of piping that filled all requirements of the service for which it was designed, namely, 125 lb. working pressure, without any of those features in its makeup that might be called extravagant or unnecessary. The drawing speaks for itself so that a description would be merely repetition.

A Machinist's Engine Room Experience

By Donald A. Hampson

When the new engineer at the woolen mills shut down the engine on his first night he failed to open the drips and he also closed the exhaust valve. As the throttle valve leaked considerably, a great quantity of condensation lodged in the cylinder. With conditions unchanged, he started up the next morning and things happened on the return stroke of the engine.

Instead of the usual cylinder-head accident, the connecting-rod bent to an obtuse angle. On the forward stroke it failed to straighten out and the movement of the flywheel, weighing several tons, turned the shaft within the crank until the key was crushed into a "Z" shape.

Attempts to remove the key with a sledge-hammer failed utterly, so a brace was rigged up from the wall for ratchet drilling. After a 1½-in. drill had been run 10 in. into the 14-in. long key, it was possible to drive out the piece. The crank was sent to the shop to be dressed and the keyseat was chipped out for a 1½x2¼-in. key and also for a 1½-in. square key which the owner insisted on having put in on the quarter. When assembled and fitted, using a 16-lb. sledge, it was reasonably certain the keys would never fail again.

The engine was a Corliss and had broken the bell-crank on one of the admission valves. When removing the valve a ½-in. nut was found wedged between its edge and the seat. How it got there was a mystery. The plant was 5 miles off in the woods and the machinery was chiefly that discarded from other plants. Naturally the engineer had to be "all hands and the cook," aided by his assistants. The buildings were strung out along the brook, with the boiler room 200 ft. up the valley in another building.

It developed that one of the "assistants" had been reseating the globe valve over one of the boilers a fortnight before the accident to the engine and had dropped the nut holding on the handwheel into the steam pipe, and had then closed the valve and said nothing about it. This same nut had been carried through the 200 ft. of pipe, the throttle valve on the engine, and had failed in its attempt to reach the open air again.

"We want a man to measure our cyl inder for a new piston ring," said the call from the glass works. When the writer reached there, the engineer and the "boss" were waiting around the piston and cylinder head which they had taken out. The piston head was of the built-up type with cast-iron spider and follower and a bronze bull ring grooved for four rings and split diagonally. The bull ring was broken into five pieces and, judging from the smoothed edges, it had been so a long time; likewise, the faces of the grooves were worn so that a shoulder near the bottom was quite distinguishable, showing that the expansion rings had had "a little movement all their own" for many days.

When the writer asked to be shown the rings he was told, "Dere vos no odder rings. Der brass ist der ring." Wonderful! He learned also that during the plant's seven years' operation the cylinder had not been opened, and that the amount of exhaust steam had always seemed abnormal required no stretch of the imagination to credit.

The writer was instructed to make a new ring like the broken bronze one, but no cast-iron expansion rings. A plea to do the latter availed nothing—partly due probably to the writer's appearance perhaps suggesting a lack of experience. However, castings were made for a complete set of five rings and turning the bull rings had just been finished when the boss came in the shop. With the air of a man springing a new one, he displayed a piston ring from an 8x14-in. engine loaned him by a friend as a sample of what should be put in the disabled engine. Without informing him that there was a similar blank casting under the lathe, the writer agreed with him that it would be a good thing to do. The next morning the entire set was working in the engine. The owner was square at heart, for a month later he telephoned his thanks for the "wery goot yob on my engine," adding that according to the figures of one month his coal bill would be reduced over $700 a year.

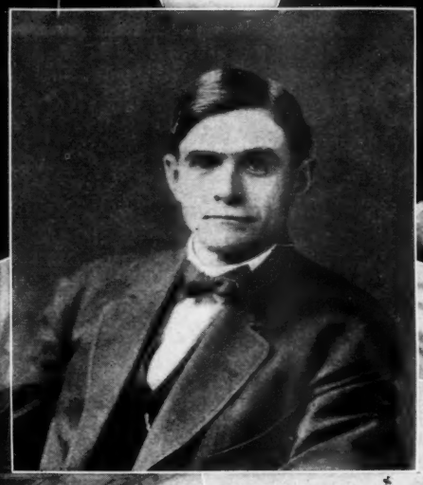
The funny side sometimes makes its appearance in the engine room. One of the engines was being "limbered up" after having its bearings babbitted, and the oil guards had all been replaced. The crankpin was a circle of bright, revolving metal made conspicuous by the nickeled arm of the oiler extending from its stand to the revolving pin.

Enter Mr. Blank, the lawyer receiver of the property during its financial troubles, who stood for a while watching that piece of ½-in. nickel tubing; then he said: "It always seems strange to me, Mr. Jones, that that slender rod could support such a heavy crank."

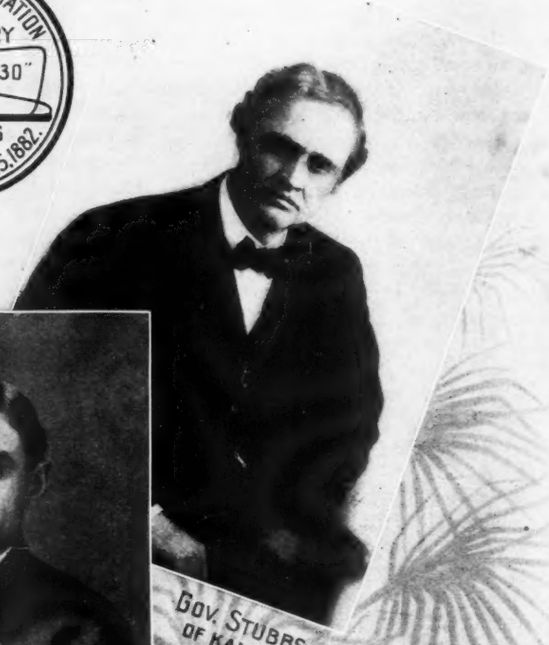
A floating dock, large enough to take the largest battleship in the British fleet, or the largest merchant vessel trading in the St. Lawrence, left England, Aug. 10, for Montreal. This dock is 600 ft. long and 135 ft. wide over all, and the walls are 59 ft. high.

30 TH ANNUAL N·A·S·E· CONVENTION KANSAS CITY.

GOV. HADLEY OF MISSOURI



MAYOR JOST OF KANSAS CITY



GOV. STUBBS OF KANSAS

CASINO HALL

CONVENTION HALL

JOHN H. ATWOOD

THE EXECUTIVE COMMITTEE:
C.E. EDGAR, E.H. LANE, J.J. WHITE, W.F GROOM, F.B. DOGGETT.

Missouri River Power Station

By A. R. Maujer

Description of plant containing a 15,000-kw. and a 5000-kw. Curtis vertical turbine; a 10,000-kw. Westinghouse-Parsons horizontal turbine, and three 3000-kw. Allis-Chalmers vertical reciprocating engines.

A feature of this plant is the duplicate main steam piping.

The larger and more important of the two generating stations of the Metropolitan Street Railway Co., of Kansas City, Mo., which operates all the street cars in that city, and its neighbor, Kansas City, Kan., is the Missouri River plant, Fig. 1, at Second St. and Grand Ave., Kansas City, Mo. The station was erected in 1904, just before the reputation of the steam turbine as a reliable and efficient machine was established, and hence the first installation of generating equipment was reciprocating-engine driven. Later, when additional capacity was needed, turbines were installed, resulting in the present mixed equipment of the station.

The building is 188 ft. wide by 260 ft. long, inside, divided into boiler house, 89 ft. wide, and engine house, 99 ft. wide. The height from the basement floor to the roof is 125 ft.; from the engine-room floor, 100 ft.

15,000-KW. UNIT

The largest capacity unit in the station is the most distant turbine seen in Fig. 2. This was installed in 1911 and stands on the same foundation formerly occupied by a 5000-kw. Curtis turbine. It is a 15,-000-kw., maximum-rating, six-stage Curtis vertical turbine running at 750 r.p.m. and generating three-phase, 25-cycle current at 6600 volts. The condenser, which is of the base type, contains 30,000 sq.ft. of cooling surface. The condensate is pumped by two Alberger 4-in. single-stage centrifugal pumps, each driven by a 25-hp. induction motor, and an Alberger 5-in. two-stage pump driven by a 50-hp. horizontal turbine running at 2500 r.p.m.

The main dry-vacuum pump is an Alberger two-stage crank-and-flywheel machine. The two vacuum cylinders, 34 in. in diameter each, are in tandem with each other and with the single steam cylinder, 12 in. in diameter; the common stroke is 24 in. The steam valves are Corliss type with a nonreleasing gear. For simplicity the secondary vacuum cylinder is the same diameter as the primary and has similar parts, and the valves are operated by the same valve rod. The vacuum cylinder walls and heads are jacketed for cooling water and the piston-rod stuffing-box of the primary cylinder has a device which diverts to the suction of the secondary cylinder any air that may leak by the outer packing, thus preventing impairment of the vacuum in the primary or high-vacuum cylinder through leakage.

To attain high efficiency by eliminating friction the ports and passages of the vacuum cylinders are especially large and direct. The detrimental influence of the clearance space thus formed is offset by using an equalizing port in the body of the mechanically operated inlet valve which, when the piston is at the end of its stroke, connects the clearance space in front of the latter with the cylinder space behind it. This allows the air at discharge pressure in the clearance space in front of the piston to expand back into the cylinder space at the other end, thus reducing the pressure in the clearance space nearly to that of the vacuum being carried and greatly eliminating thereby the prejudicial effect of re-expansion when the return stroke takes place.

The auxiliary vacuum pump for this unit is a two-stage machine of the same type with 24-in. air cylinders, 8-in. steam cylinder and 24-in. stroke.

The two step-bearing pumps are Dean, duplex outside-end packed, 14x3½x12 in. The step pressure in this turbine is 825 lb. per sq.in.

A second 15,000-kw. Curtis vertical turbine is now being installed and will be ready for service within a few months.

10,000-KW. UNIT

The next largest generating unit is the 10,000-kw., maximum-rating, Westinghouse-Parsons horizontal double-flow turbine seen at the left of Fig. 2. This operates at 1500 r.p.m.

The turbine is served by two Wheeler, admiralty-type, surface condensers containing 11,000 sq.ft. of cooling surface each. A 42-in. hydraulically operated gate valve between the turbine and each condenser allows a condenser to be cut out for cleaning without taking the turbine out of service. The condensate is handled by either of two 4-in. vertical, two-stage centrifugal pumps driven by direct-connected 15-hp. induction motors. The dry-vacuum pump is an Alberger of the same type as that for the 15,000-kw. unit except that the steam valve-gear is of the releasing type. The air cylinders are 24 in. in diameter, the steam cylinder 8 in. and the stroke is 24 in.

This unit is supported on steel struts and girders and the space beneath is occupied by the condenser pumps, gland-water pumps and the auxiliary oil pump which is used when the turbine is being started. By this arrangement considerable economy in space is effected. This unit was installed in 1910.

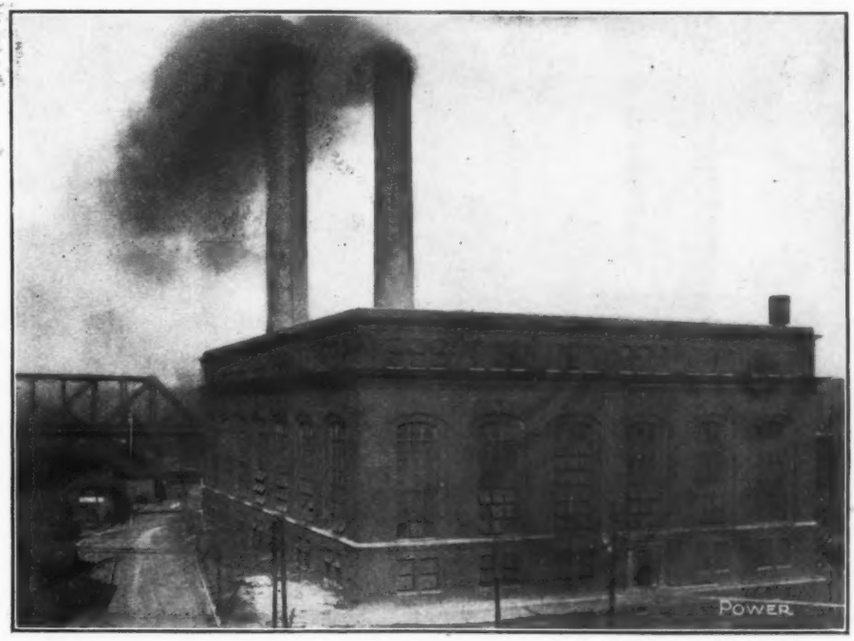


FIG. 1. MISSOURI RIVER POWER STATION

5000-KW. UNIT

The third turbine is a 5000-kw. Curtis vertical five-stage machine, running at 750 r.p.m., and having an overload capacity of 50 per cent. This unit also is supported on steel struts and girders instead of a solid concrete foundation, in

the same manner as the Westinghouse-Parsons unit. It was installed in 1906.

The condenser for this turbine is of the Wheeler exhaust-base type and contains 10,000 sq.ft. of cooling surface. Two 42-in. hydraulically operated gate valves between this turbine and its condenser make it possible to cut out this condenser also, without shutting down the turbine. Two single-stage 4-in. centrifugal pumps, driven by 15-hp. induction motors, take care of the condensate. The dry-vacuum pump is an Alberger two-stage of the same size and type as that for the Westinghouse-Parsons unit. The same step pumps supply this turbine that supply the 15,000-kw. unit. The step pressure is maintained at 570 lb. per sq.in. A single accumulator supplies both of the Curtis units. This maintains a pressure of 1100 lb. per sq.in.

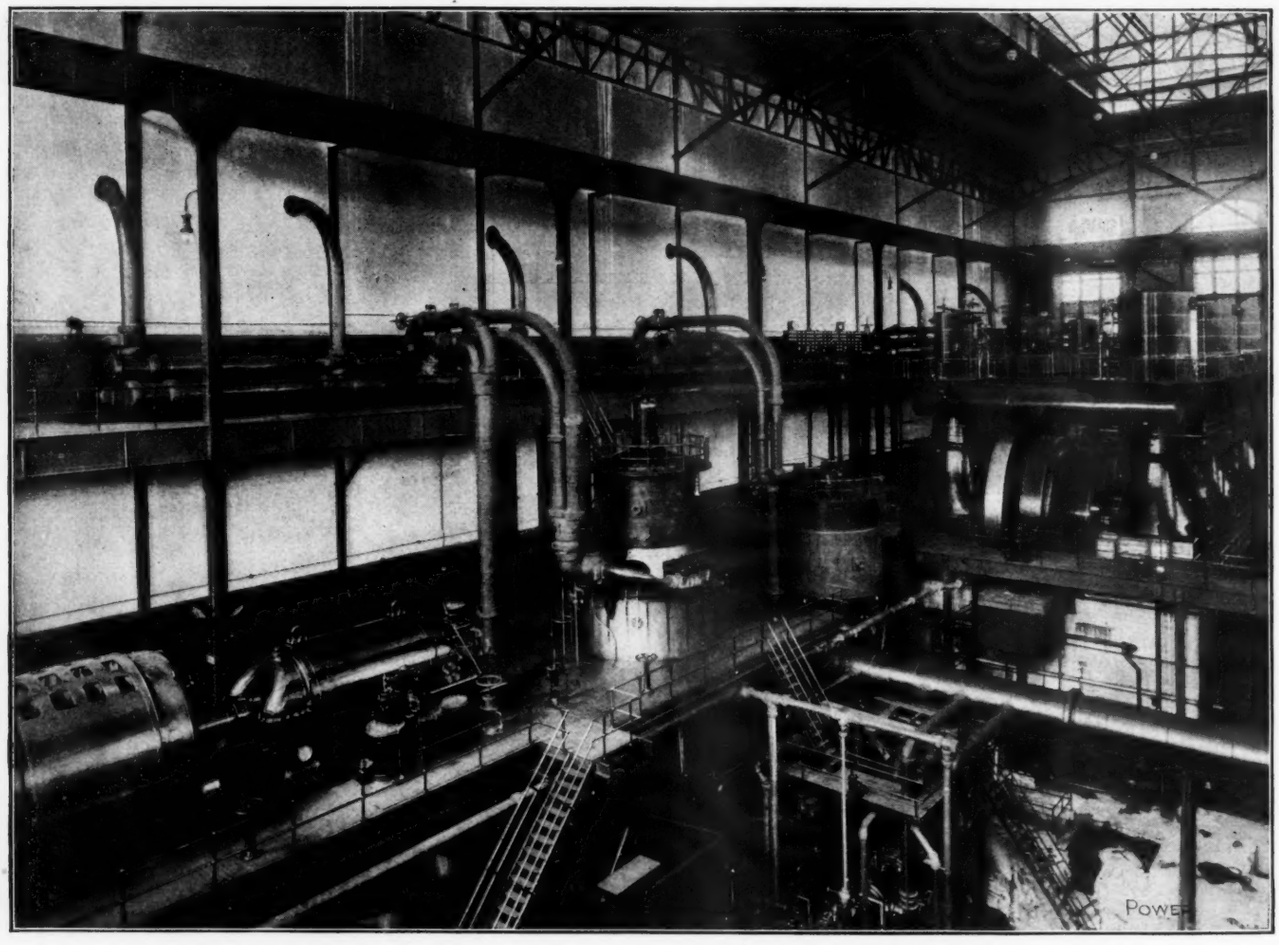


FIG. 2. THE ENGINE ROOM, SHOWING SOME OF THE AUXILIARIES IN THE BASEMENT

RECIPROCATING ENGINES

The three reciprocating-engine units at the far end of the station, as seen in Fig. 2, are all of 5000-hp. rated capacity, each running at 75 r.p.m. They are Allis-Chalmers 46 and 94 by 60-in. vertical cross-compound engines, fitted with Corliss valves. The dynamos were built by the General Electric Co. and are of 3000-kw. rated capacity, with an overload rating of 50 per cent.

Each engine is served by a separate surface condenser containing 10,000 sq.ft. of cooling surface. The condensers have Blake 14x38x21-in. combined air pumps.

The engines are oiled by a gravity system which gives a pressure of about 40 lb. per sq.in. at the bearings. The overhead tank has a capacity of 600 gal.

A few figures contrasting the size of one of these engine units with a turbine unit may be of interest. An engine occupies an area of 1776 sq.ft. while the 15,000-kw. turbine occupies 306 sq.ft. In an engine the total weight on the bearings is 520,000 lb. while the total weight of the moving parts of the turbine is 200,000 lb. Referring these figures to the unit of rated capacity, the engine area per kilowatt is 0.592 sq.ft. and the weight of the moving parts, 173 lb. The turbine area per kilowatt is but 0.0204 sq.ft. and the weight of moving parts 13.33 lb.

Fig. 3 shows the two motor-driven 150-kw. exciter sets running at 500 r.p.m. and one horizontal steam-turbine-driven 300-kw. unit running at 1800 r.p.m.; all generate current at 125 volts. A storage battery for excitation contains 78 cells. All of the exciters can be operated in parallel with each other or with the battery. The exciters may also be operated in series for charging the battery.

The high-tension oil switches are on the engine-room floor along the wall between the engine room and boiler room. There are 42 switches in all, six Westinghouse type and 36 General Electric, all remote control. The former are solenoid operated and the latter motor operated.

The engine room contains a Pawling & Harnischfeger motor-operated crane with a main-hoist capacity of 60 tons and an auxiliary-hoist capacity of 15 tons. Its span is 70 ft. and the lifting range 58 ft.

BOILERS

In the boiler room are 40 B. & W. 600-hp. boilers, arranged in two tiers, one over the other. These generate steam at 175 lb. and have superheaters giving about 100 deg. of superheat. Four of the boilers have Foster superheaters and the rest B. & W. Coal is burned under 36 of the boilers and fuel oil under the other four. The coal-burning boilers have Green chain grates; two of the oil-burning boilers have C. Y. Roop burners and the other two Billow burners.

Two radial brick stacks, 265 ft. high above their foundations and 16 ft. in internal diameter, supply the draft. Two flue connections lead into each stack, and the stacks have brick baffle walls extending well above the flue openings.

Coal is unloaded from cars on the railroad siding at the end of the boiler house into hoppers feeding it into the buckets of two Mead-Morrison motor-driven conveyors which raise it to the overhead bunkers, both on the same level above the upper tier of boilers. The conveyors have a capacity of 70 tons per hour when traveling at 40 ft. per minute. The buckets are of the overlapping type, 24x24 in. in size. The total bunker capacity is 12,000 tons.

From the bunkers the coal is fed into traveling hoppers by which it is distributed to the stokers. At one end of the plant one hopper serves two boilers while at the other, one serves four.

The return runs of the conveyors extend under the ashpit hoppers and receive the ashes, which they carry to two cylindrical hopper-bottom tanks over the railroad siding, each holding three carloads.

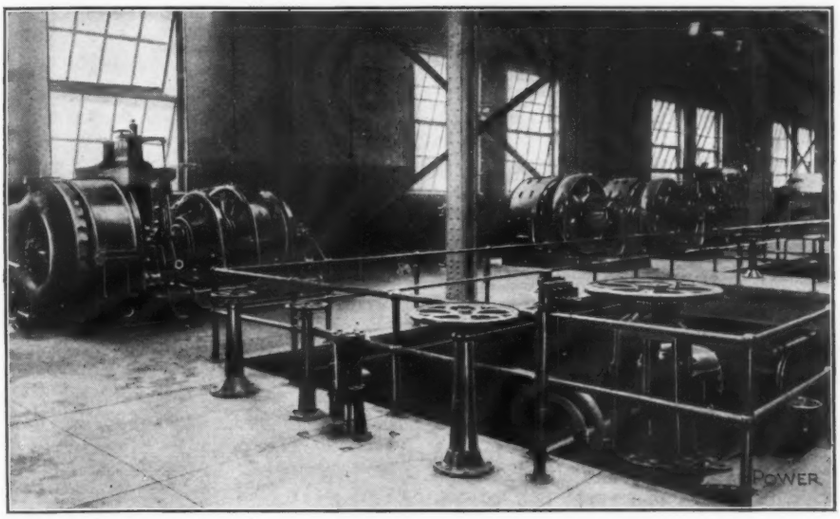


FIG. 3. EXCITERS IN THE MISSOURI RIVER STATION

FEED PUMPS

There are four Blake compound duplex feed pumps with steam cylinders 12 and 20 in. in diameter, water cylinders each 10 in. in diameter and a stroke of 18 in. The water ends are of the outside end-packed pot-valve type. The 5-in. feed-water mains are in duplicate throughout.

Three Blake 6x14x12-in. simplex pumps raise the water from the hotwell to the feed-water heaters. The hotwell for the engines is 12 ft. wide, 25 ft. long and 9 ft. deep. The condensate from the turbines is pumped direct to the heaters. Four Webster open-type induction heaters of 5000-hp. capacity each, raise the boiler-feed temperature to about 170 deg. F., and receive the exhaust steam from all of the auxiliaries.

PIPING

An interesting feature of the main steam piping is the fact that it is in duplicate throughout. Two main steam headers, each 18 in., extend along the engine-room wall on the mezzanine gallery, as shown in Fig. 2. These are anchored at the middle, allowing expansion both ways. Each pair of boilers connects through a long-radius bend to a header. Alternate pairs connect into the same header, so that not more than two boilers ever need to cut out to work on a branch. The leads to the reciprocating engines are 10 in. and in duplicate up to the throttle valve. The lead to the 5000-kw. turbine also is in duplicate to the throttle, but for the Westinghouse-Parsons unit only the bends from the headers are in duplicate and for the 15,000-kw. Curtis unit the lead is in duplicate half way to the throttle. All of the turbine leads are 12 in. in diameter.

All condensation from the piping system is returned to the boilers by a Holly system steam loop.

The steam mains for the auxiliaries are connected to the boilers by separate 4-in. connections containing automatic nonreturn valves. They form two inter-connecting loops varying in diameter from 6 to 5 in., one of which feeds the turbine auxiliaries and the other the engine auxiliaries and the steam-driven exciter. The feed pumps are supplied by two 7-in. branches which connect with the main headers and also with the two auxiliary loops.

A 48-in. main atmospheric exhaust header, to which all of the units are connected, extends the length of the building beneath the engine-room floor and connects with a 60-in. exhaust stack at one end and a 48-in. stack at the other.

CIRCULATION WATER SYSTEM

The cooling water for the condensing system is obtained from the Missouri River, 1200 ft. away. A small brick and concrete building, on the bank of the river, contains the equipment shown in Fig. 4. Four 30-in. steel-pipe siphons allow the water to flow from the river into four suction wells 12 ft. square. After passing through the screens, made of flat iron bars on edge, the water flows to the various pump-suction pipes. The seven vertical centrifugal circulating pumps were built by the Morris Machine Works and are driven by General Electric induction motors running on three-phase, 25-cycle alternating current at 440 volts. Three of the pumps are driven by 200-hp. motors, are of 10,000 gal. per min. capacity and have a 20-in. discharge opening; three are driven by 125-hp.

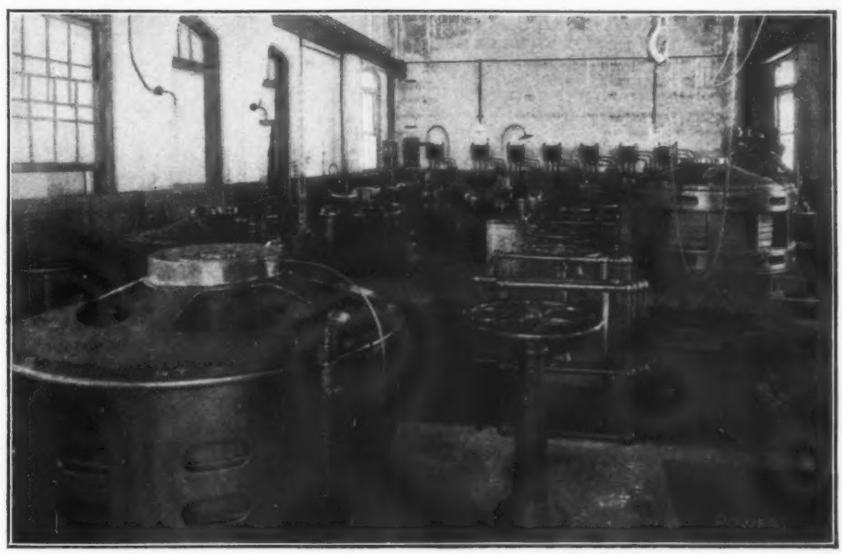


FIG. 4. CIRCULATING WATER PUMP HOUSE

motors, are of 6000 gal. capacity and have an 18-in. discharge, and one is driven by a 75-hp. motor, has a capacity of 3000 gal. per min. and a 12-in. discharge.

The pumps discharge into two 48-in. flow lines, which enter the generator house at the same end but at opposite sides and extend its length. They are cross-connected at each turbine by a 30-in. pipe so that they may be used interchangeably.

A small two-cylinder single-acting 8x 12-in. vacuum pump, gear-driven by a 10-hp. induction motor, frees the siphons of any air liberated from the water in flowing into the suction wells and trapped in the tops of the siphons.

Auxiliary Plant

This company also operates a direct-current plant in Kansas City, Kan., known as the Kaw River Station. It was erected in 1896 and contains four generating units. Two are horizontal tandem-compound E. P. Allis Corliss engines driving 550-volt direct-current generators. The larger is a 30 and 60 by 48-in. engine and runs at 80 r.p.m., driving a 1500-kw. dynamo and the smaller is a 22 and 44 by 48-in. engine, running at 90 r.p.m. and driving a 1200-kw. dynamo. The other two are horizontal cross-compound E. P. Allis Corliss engines. One, a 36 and 72 by 60-in. engine, runs at 75 r.p.m. and drives a 1500-kw. dynamo. The other is a 28 and 56 by 60-in. engine, runs at 80 r.p.m. and drives a 1200-kw. dynamo. All have Wheeler surface condensers.

The boiler equipment consists of six B. & W. 250-hp. water-tube boilers and six Aultman & Taylor 500-hp. water-tube boilers.

Water Works of the Kansas Cities

Description of the pumping station and municipal light and power plant of Kansas City, Kan., together with the low- and high-head plants of Kansas City, Mo.

Centrifugal pumps are employed for the low-head stages and the standard types of high-duty pumping engine for the high-head.

Usually any large city's water-works is interesting if for nothing else than its massive engines, mighty in appearance but surprisingly small in actual power developed, because they ordinarily run so very slow. The works of the Kansas Cities are particularly so because the Missouri River water, which constitutes the supply, requires treatment before it can be used for general purposes. The water must be pumped twice for Kansas City, Kan., and three times for its neighbor across the Kansas River, Kansas City, Mo.

The intakes for both cities are within a few hundred feet of each other in Kansas City, Kan., on the Kansas side of the Missouri River above where the Kansas River empties into the former and north of the city. They were located there to avoid the sewerage from the two cities and any that might be brought down the Kansas River from towns above. No settlements of any consequence are on the Missouri River for 25 miles or more above the two cities and hence, except for its extremely muddy condition, the water is fairly good to drink, as the fact that Kansas City, Mo., is the second city in point of health, alone would tend to prove.

Kansas City, Kan., Plant

Kansas City, Kan., is one of the progressive cities of a progressive state and its original water-works, erected in 1895, recently were found to be inadequate and obsolete; hence, it has a new plant, erected in 1911, which may be fairly considered to represent the best practice in this type of works. In Fig. 1, the old pump house is the low, gable-roof building at the right. The new pump house is in the right end of the new building with its steel stack beyond. At the left end of this building, just being completed, is the city's electric light and power station, mentioned later.

Water is drawn from the river by low-head pumps and discharged into settling basins where, while flowing from one basin to another, lime and alum are added to coagulate and precipitate the fine particles of clay held in suspension which make the water muddy. The water is then passed through sand filters to remove other impurities and the greater part of any bacteria it may contain. High-pressure pumps then take the water and discharge it into the distributing mains.

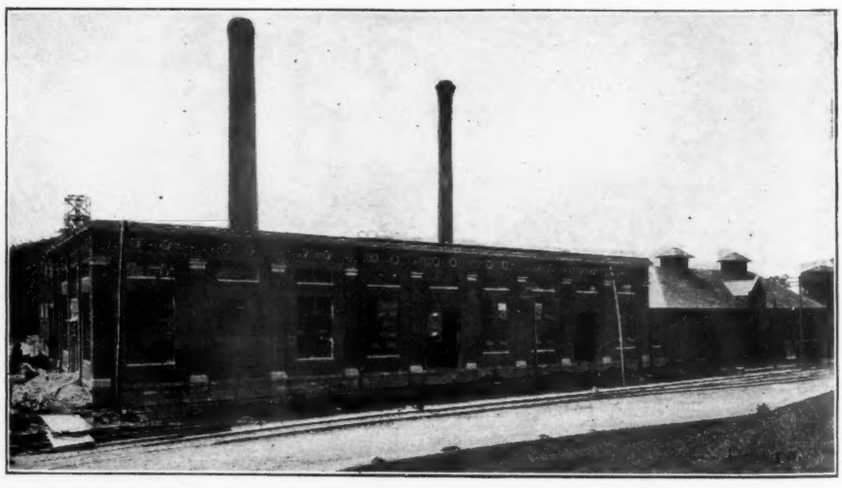


Fig. 1. Kansas City, Kan., Electric Light Plant and Pumping Station

Old Pumping Station

The boiler house of the old pumping station contains six water-tube boilers, four of 200-hp. and two of 250. These are permanently out of service now and will be removed when the old plant is demolished. The pumping equipment includes one Holly, vertical triple-expansion high-duty pumping engine for the low-head stage and three Worthington horizontal duplex pumps for the high-pressure service. The capacity of the low-head unit is 8,000,000 gal. per 24 hr. against a total head which varies from 24 to 44 ft., depending upon the condition of the river. This machine will be remodeled, the water end will be enlarged and it will be moved into the new pump house at a cost of about $20,000. The capacities of the three high-pressure units are 3,000,000, 6,000,000 and 9,000,000 gal. per 24 hr. respectively. Although these are still used during certain parts of the day, they will be dismantled eventually and removed.

New Pumping Station

In the new pump house the water is handled for the low-head stage by the unit shown in Fig. 2. The engine is a horizontal tandem-compound condensing Monarch Corliss, 12 and 26 by 24 in., built by the H. N. Strait Manufacturing Co. The steam inlet is 4 in. and the exhaust 10 in. in diameter. The heads of

both the high- and low-pressure cylinders are steam jacketed and the receiver has reheating coils which superheat the steam from 8 to 10 deg. The condenser is set alongside the pump discharge from which it receives the cooling water. The air pump is of the separate steam-driven type but exhausts into the main exhaust line and hence operates condensing.

The pump is of the double-inlet centrifugal type built by the same company. The impeller diameter is 7½ ft., the inlets are 18 in. and the discharge is 24 in. in diameter. When running at 150 r.p.m., the capacity is 15,000,000 gal. per 24 hr. On the official test this unit showed a duty of 95,000,000 ft.-lb. per 1000 lb. of dry steam at 150-lb. pressure, which is considered high for this type of pumping unit.

High-pressure Pump

The high-pressure pump is shown in Fig. 3. This is a Snow, horizontal cross-compound, crank-and-flywheel type, high-duty, direct-displacement pump, 27x60x 19x42 in., having a capacity of 12,000,000 gal. per 24 hr. when running at its normal speed of 43 r.p.m. The steam-pipe connection is 6 in. in diameter and the exhaust 16 in. The receiver is supported on columns bolted to the engine frames and contains reheating tubes using live steam. A 1200-sq.ft. surface condenser is in the suction main between the two sides of the pump end and all the water pumped passes through the condenser and around the tubes. The air pump is of the single-acting bucket type driven by an arm from the low-pressure crosshead.

The valve-gear is the Snow Corliss wide-range type for both the high- and low-pressure cylinders, permitting cutoff at any point in the entire stroke. Single eccentrics are used. A Snow patent pressure regulator is connected to the high-pressure cutoff. Operated by the water pressure in the discharge main, it keeps the discharge pressure practically constant by varying the engine speed to meet the consumption.

The flywheel, 14 ft. 7 in. in diameter, weighing 35,000 lb. and cast in halves, is in the center of the engine midway between the steam and water ends. A special feature of the engine, added for efficiency and durability, is the tailrod of the low-pressure piston extending to a crosshead sliding on an outboard bearing. This is rather unusual on this type of engine except on the large sizes.

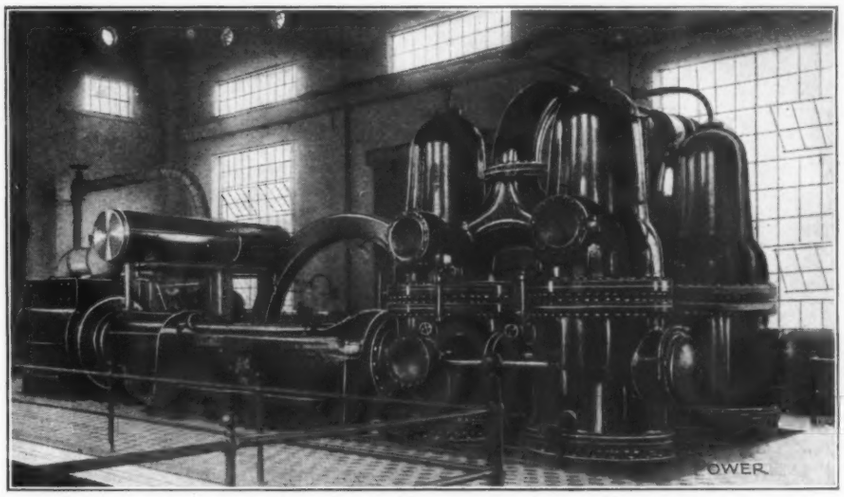


Fig. 3. High-pressure Pumping Engine at Kansas City, Kan., Plant

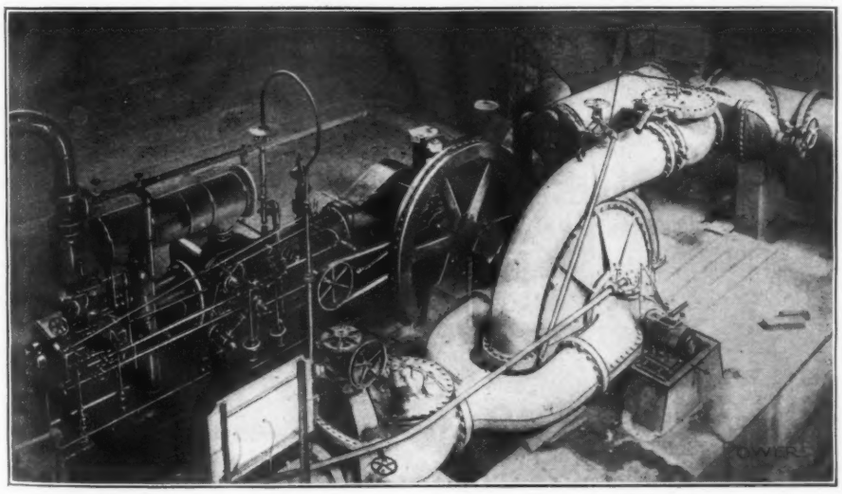


Fig. 2. Low-head Pump at Kansas City, Kan., Plant

The pump end is of the Snow outside-packed double-acting plunger built-up type. The principal castings are iron except the valve decks, which are cast steel of the double-flanged type. The pump valves, 3⅜ in. in diameter, are mounted on cages bolted to the deck. The valve area is such as to permit an average water velocity through the valve seats of 2½ ft. per sec.

In the boiler house, which is separated from the pump house by an alley 20 ft. wide, are four 300-hp. Heine water-tube boilers with Illinois chain-grate stokers. These boilers are served by the steel stack seen in Fig. 1, 135 ft. high by 6 ft. in diameter.

The boilers are fed by two Blake-Knowles 7½x5x10-in. horizontal duplex plunger pumps.

Municipal Electric Light and Power Plant

In the left end of the new building, Fig. 1, the municipal electric-light and power plant is now being installed. In addition to equipping its streets throughout with electric light the city plans to sell current for domestic and general lighting and power. It is expected that the lighting rate to small consumers will be 5 or 6 cents per kw.-hr. flat and the power rates will range from 1 to 3 cents.

Fig. 4. Quindaro Pumping Station of Kansas City, Kan.

The initial equipment will include a 500- and a 1000-kw. turbine generating alternating current at 2300 volts. Space has been provided for a future 2500-kw. machine of the same type. An interesting feature is the floor construction of the generator room. Instead of building independent foundations for each machine the floor itself was made sufficiently heavy

to carry the weight of the largest units that the space will accommodate. If the load outgrows the present equipment, substituting larger units will be simple, as tearing out old foundations and putting in new ones will not be necessary.

In the boiler house will be one 300-hp. Heine, one 300-hp. B. & W. and two 500-hp. Bonus-Freeman water-tube boilers. Room is provided for two additional 500-hp. boilers. The stack to serve these boilers is 150 ft. high by 11 ft. in inside-top diameter, of the tapered reinforced-concrete type.

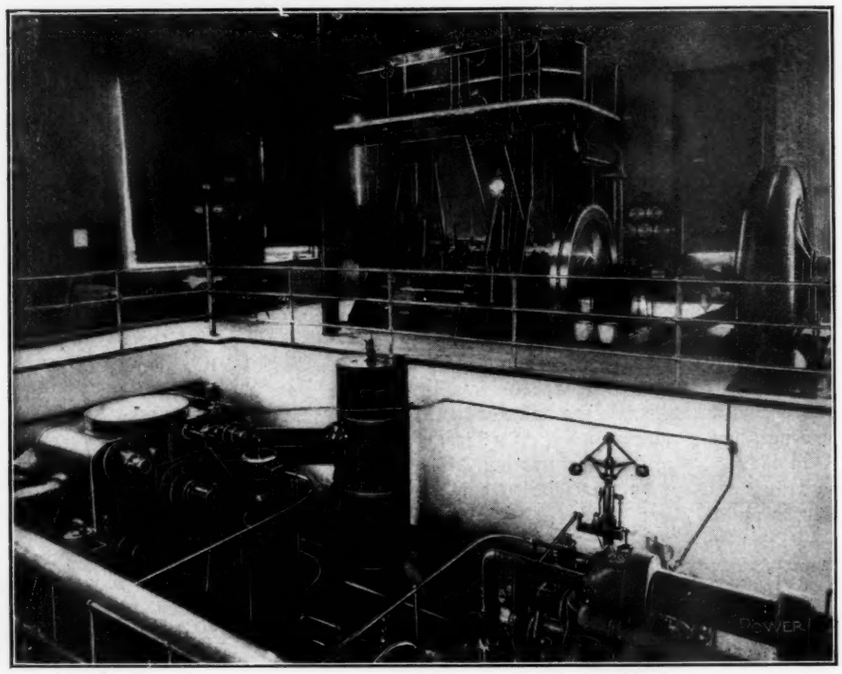


FIG. 5. PART OF THE EQUIPMENT IN THE QUINDARO STATION

The boilers of the lighting plant will interconnect with those of the pumping station and the two plants will be under the charge of one chief engineer.

KANSAS CITY, MO., LOW-HEAD PLANT

The low-head plant, known as the Quindaro station, of Kansas City, Mo., is within a few hundred feet of the plants just described. An exterior view is shown in Fig. 4, and an interior in Fig. 5. Here one set of pumps raises the water from the river to the settling basins against a mean head of 35 ft. These basins, five in number, hold altogether about 90,000,000 gal. The two suction lines from the river to the first set of pumps are 42 and 48 in. in diameter, respectively, and 800 ft. long.

There are three river pumps. One is a 25,000,000-gal.-per-24-hr. double-suction centrifugal pump, built by R. D. Wood & Co., directly connected to a Russell 13 and 26 by 24-in. horizontal tandem-compound engine, running at 200 r.p.m. Each suction inlet is 24 in. in diameter and the discharge is 30 in. The impeller is 76 in. in diameter. The two other units were built by the Allis-Chalmers Co., and are each of 30,000,000 gal. capacity per 24 hr. The engines are cross-compound vertical type with Corliss valve-gear throughout. The cylinders are 14 and 30 in. in diameter and the stroke is 24 in. The normal speed is 140 r.p.m. The three pumps discharge into a 48-in. main which delivers the water to the settling basins, 800 ft. away.

Three centrifugal pumps force the water from the settling basins to the receiving reservoir at the high-pressure pumping station at Turkey Creek, across the Kansas River in Kansas City, Mo. These pumps receive the water from the settling basins through two lines, one of which is 36 in. in diameter and the other, 42 in. One of the pumps was built by the Allis-Chalmers Co., and is the same size and design as the other two built by this company. The piping provides that, in emergency, this pump may be used for raising water from the river. The other two pumps are of 25,000,000 gal. capacity each. One was furnished by R. D. Wood & Co., and is a duplicate of their other pump. It is driven by a vertical cross-compound 14 and 28 by 24-in. Corliss valve engine, built by the H. N. Strait Manufacturing Co., running at 180 r.p.m. The other 25,000,000-gal. pump was furnished by the Byron Jackson Machine Works and is driven by a 14 and 28½ by 24-in. vertical cross-compound engine built by the Quincey Engine Co., running at 180 r.p.m.

These pumps discharge into a 36-in. and a 48-in. pipe 3½ miles long, which connect with a tunnel 7 ft. in diameter, 1125 ft. long, extending under the Kansas River. This tunnel discharges into two 30-in. pipes and one 48-in. on the other side of the river which extend 2¼ miles to the reservoir at the Turkey Creek Station.

A 50-kw. Kerr turbo-generator furnishes current at 220 volts for light and power about the plant.

The boilers, although all of water-tube type and the same general design, are of rather assorted manufacture. Of the seven boilers, two are Aultman & Taylor 300 hp., two are Stirling 300 hp., one is a Tudor 200 hp. and two are Erie 350 hp. The last two have just been installed. All are fired with coal. The Erie boilers have Green chain-grate stokers and the others Mansfield chain grates.

TURKEY CREEK PUMPING STATION

Fig. 6 is a view of the Turkey Creek pumping station, the largest of the plants. Here the water is taken by a third set of pumps from the small reservoir back of the station and delivered into the distributing mains at 150 lb. pressure.

The present building was erected in 1904 over the old station. The old building was not demolished until the new one was practically completed as it was impossible to leave the equipment without protection from the elements, and the water service had to be maintained while the changes were being made. The present plant is 188 ft. long, 92 ft. wide, and 77 ft. high from the basement floor to the roof.

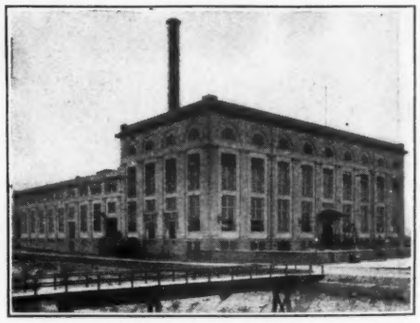


FIG. 6. TURKEY CREEK PUMPING STATION

The present pumping equipment includes five units having a total capacity of 85,000,000 gal. per 24 hr. The first to be installed in the new building is shown in Fig. 7. This has a horizontal four-cylinder triple-expansion Corliss engine steam end. The high-pressure and one low-pressure cylinder are arranged tandem on one side, and the intermediate-pressure and the other low-pressure cylinder are similarly arranged on the other side. The cylinders are 24, 42, 50 and 50 in. in diameter and the stroke 42 in. The steam-supply pipe is 8 in. and the exhaust pipe from each low-pressure cylinder 24 in. Each side of the engine discharges into its own surface condenser, having 3842 sq.ft. of cooling surface.

The vacuum pumps on this and the other engines in the station are driven directly from the engine, as is customary in plants of this kind.

The water cylinders have Riedler patent mechanically operated valves. The water plungers are 20½ in. in diameter, and the capacity is 20,000,000 gal. per 24 hr.

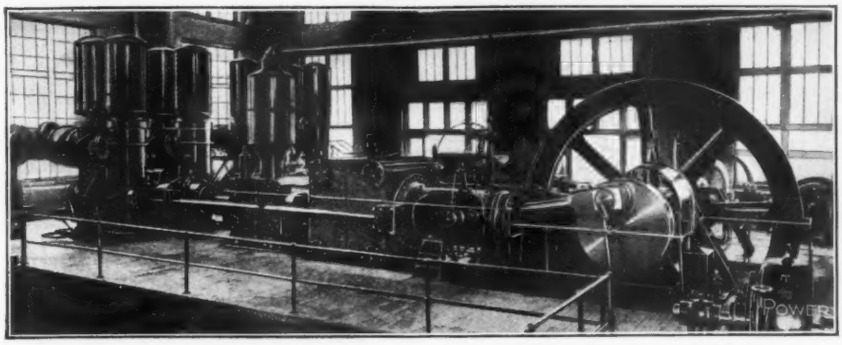


FIG. 7. HORIZONTAL TRIPLE-EXPANSION PUMPING UNIT IN THE TURKEY CREEK STATION

when running at the maximum speed of 60 r.p.m. The suction pipe is 36 in. and the two discharge pipes are 30 in. each. The suction head is 11 ft. This entire unit, including the condensers, was furnished by the Allis-Chalmers Co.

The next engine was installed in 1907. It is of the vertical triple-expansion type, as shown in Fig. 8. The steam cylinders are 38, 72 and 108 in. in diameter and the stroke 66 in. The pump plungers are 32⅜ in. in diameter and, when running at the maximum speed of 20 r.p.m., the pump will deliver 20,000,000 gal. per 24 hr. The diameter of both the suction and discharge is 36 in. The normal suction head is zero as the pump is on the level of the water in the reservoir under normal conditions. The engine has one surface condenser having 2509 sq.ft. of cooling surface. The condenser is in the pump suction line, according to the common practice with engines of this class, and hence receives the cooling effect of all the water handled. The steam and exhaust valves on the high-pressure cylinder and the admission valves on the intermediate are of the Corliss type; those on the intermediate exhaust and on both ends of the low-pressure cylinder are of the poppet type. This unit was built by the William Tod Co.

A 15,000,000-gal. Allis-Chalmers unit was installed in 1910. This also is of the vertical triple-expansion type and is 34, 62 and 94 by 60 in. in size. The high-pressure admission valves are Corliss while all the rest are poppet. The maximum speed is 22 r.p.m. The condenser contains 2016 sq.ft. of cooling surface and is in the suction line. The pump plungers are 28 in. in diameter, the suction is 36 in. and the discharge 30 in. The vacuum pump is directly connected in the usual manner.

The latest unit to be installed is shown in Fig. 9. It is also of Allis-Chalmers make and was installed last spring. The cylinders are 40, 73 and 110 in. in diameter and the stroke 66 in. The valves of the high-pressure cylinder and the intermediate admission valves are Corliss, while the rest are poppet. The condenser contains 2500 sq.ft. of cooling surface. The maximum speed is 20 r.p.m., giving a capacity of 20,000,000 gal. per 24 hr. The pump plungers are 32¼ in. in diameter. The suction is 36 in. and one of the two discharge pipes is 31 in. and the other 36 in.

The oldest engine in the station is shown in the foreground and at the right of Fig. 8. This is a vertical triple-expansion engine, equipped with Corliss

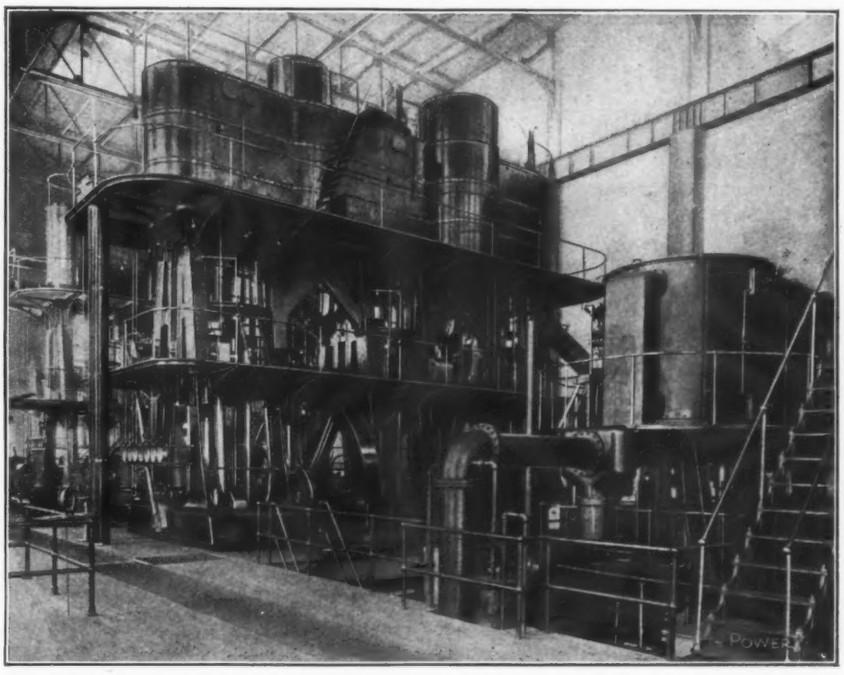


FIG. 8. BARR ENGINE IN FOREGROUND AT RIGHT; TOD ENGINE BEYOND

valves throughout, built by the Barr Pumping Engine Co. It was installed in 1896 in the old station and stands on its original foundation today, having done duty during all the time that the new station was being built over it and the old one demolished. It has 28, 48 and 72 by 42-in. cylinders and runs at a maximum speed of 29 r.p.m. The pump plungers are 24 in. in diameter and the capacity is 10,000,000 gal. per 24 hr.

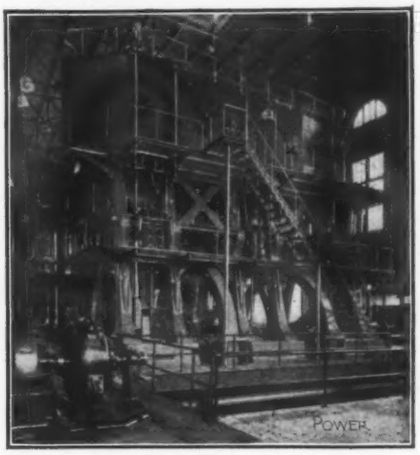


FIG. 9. THE NEW ALLIS-CHALMERS UNIT

Both suction and discharge are 30 in. in diameter.

BOILER EQUIPMENT

In the boiler room are six Aultman & Taylor water-tube boilers of 350 hp. each, two National water-tube boilers of 300 hp. each, and two Erie City water-tube boilers of 350 hp. each. The six Aultman & Taylor boilers, Fig. 10, have Billow fuel oil burners while the rest have chain-grate stokers. Fuel oil and coal at Kansas City for equivalent steam production cost practically the same; hence, oil-burning and coal-burning plants are found in close proximity and a few plants, like the Turkey Creek, use both fuels. From the increasing price of oil, however, its

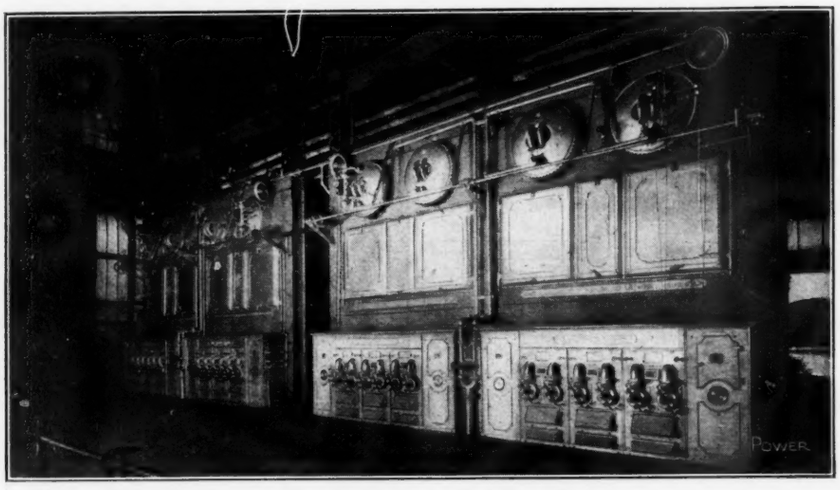


FIG. 10. GROUP OF OIL-BURNING BOILERS AT TURKEY CREEK STATION

use will probably soon be largely discontinued.

There are three boiler-feed pumps, one a Dean Bros. 8x12x8-in. horizontal duplex plunger type; one a Worthington 6x8x6-in. vertical duplex marine type, and one a Barr of the same type and size as the Worthington.

Fuel oil is stored in four steel tanks 200 ft. south of the station, each holding 500 bbl. The oil-pumping equipment is in duplicate and consists of two 4x4x3-in. duplex pumps with a heater attached to each and mounted on the same stand.

Coal is brought alongside of the boiler house on a siding and unloaded into industrial railway cars running into the basement, where they are elevated to the boiler-room floor on hydraulic lifts in front of the boilers. The ashes drop into hoppers under the boilers from which they are emptied into the industrial cars and from these loaded into wagons to be hauled away.

PIPING AND AUXILIARIES

One 8-in. header directly above the boilers extends the length of the room. This is cross-connected to the 10-in. main header supported on the engine-room wall. The 8-in. cross-connections are so arranged that any boiler or any engine may be isolated without interfering with any of the others.

Two small high-speed automatic engines driving 50-kw. direct-current dynamos in one corner of the engine house supply current at 220 volts for light and power in the station and the machine shop adjoining.

Two 50-cu.ft. capacity two-stage steam-driven air compressors force air into the air chambers of the various pumping engines. The air is injected daily.

MACHINE SHOP

Adjoining the boiler house is a well equipped machine shop in which all repairs for the entire plant are made. Also, the street hydrants are finished here, the rough castings being bought from a commercial foundry. By having this latter work to do between repair jobs it is possible to retain the machine-shop force practically intact and consequently maintain it in a well organized condition. The shop equipment comprises four lathes, one 20 ft. long with a 42-in. swing, one 16 ft. long with a 20-in. swing, one 12 ft. long with a 16-in. swing, and one 10 ft. long with a 14-in. swing; one American shaper with 20-in. travel; one Kempsmith No. 3 milling machine; one American radial drill; one American drill press, and one hacksaw. All of the tools are driven by individual motors.

Power Plant of the "Kansas City Star"

Description of a plant devoted exclusively to printing a newspaper. Crude oil is used for fuel and the plant contains three Corliss engine-driven generators aggregating 700 kw.

Details of the electric drive for the presses are given.

The *Kansas City Star*, one of the leading newspapers of the Middle West, has as fine a home as any paper in the United States, and one which is different. After crowding itself out of house and home several times in its 32 years of existence, its owner decided, when the present plant was built in 1909, that it should be made ample to permit considerable expansion in the working force and equipment without causing discomfort or inefficiency.

The building shown in Fig. 1 is the result. This entire structure, 250 ft. wide by over 110 ft. deep and three stories high with a basement and sub-basement, is devoted solely to the business of issuing a newspaper. Many of the features about the arrangement of the building and the equipment for manufacturing and setting the type, making the engravings and casting the cylindrical plates, are extremely interesting, but space cannot be given to their description, since they are not pertinent to POWER's field.

As can well be imagined, the power-generating equipment is very modern. The boilers are in the sub-basement, 11 ft. below the engine-room floor; two of the three installed may be seen in Fig. 2. The third faces these two, across the firing aisle. Each is of the Bonus-Freeman box-header water-tube type and of 350 hp. There are 155 tubes in each boiler, 4 in. in diameter and 20 ft. long, and two drums 36 in. in diameter. The feature of these boilers is their extremely free circulation due to the large cross-sectional area of the headers and nipples and the high pitch of the tubes, which is 1½ in. to the foot. The large sectional area of the headers also gives them great water-storage capacity and steam-liberating area, which latter tends to produce dry steam.

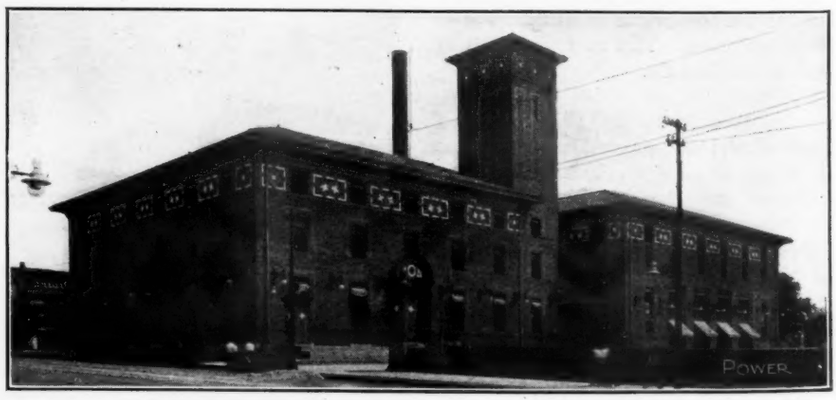


FIG. 1. HOME OF THE "KANSAS CITY STAR"

Oil Burning System

Oil is burned under the boilers at present, but coal storage facilities have been provided and a change to this fuel can be made easily and quickly. The burners are of the C. Y. Roop internal-mixing pattern. The fuel oil is delivered in wagons to three rectangular storage tanks buried under the sidewalk. Each tank is 16 ft. long by 8 ft. wide at the bottom, 9 ft. at the top and 15 ft. deep, holding 15,500 gal. The oil flows by gravity to the pumps which supply it to the burners. These pumps are in duplicate and are on the same stand with the oil heater which receives the exhaust steam from the pumps. They are Fairbanks-Morse horizontal duplex pumps with 1½ in. suction and 1-in. discharge. The pump speed is controlled by adjusting the throttle by hand. An automatic relief valve on the discharge line, set for 80-lb. pressure, bypasses the oil to the suction when the pump is working too fast. An automatic pump governor was not considered necessary as the fireman must regulate the supply of steam to the burners by hand and can adjust the pump speed at the same time. A Worthington piston-type oil meter in the pump-discharge line registers the quantity of oil consumed.

The feed water passes through a 1000-hp. Hoppes live-steam feed-water heater and purifier to two Burnham 12 by 7½ by 6-in. duplex plunger boiler-feed pumps, made by the Union Steam Pump Co.

The air compressor and the hydraulic elevator pumps are also in the sub-basement. Compressed air is used for forcing the printing ink from storage tanks in the sub-basement to the fountains on the six large octuple printing presses which share the basement with the electric generating equipment. Compressed air is also used to raise the oils for washing the inking rollers and for lubricating the presses and steam engines. The lubricating oil is elevated to a tank from whence it flows to the various bearings. From the latter it flows to filters in the sub-basement and thence to a small receiving tank from which it is returned to the supply tank.

Three Westinghouse motor-driven air compressors, two of 50 cu.ft. and one of 25 cu.ft. per min. capacity, compress air, for the purpose just mentioned, to 80 lb. pressure.

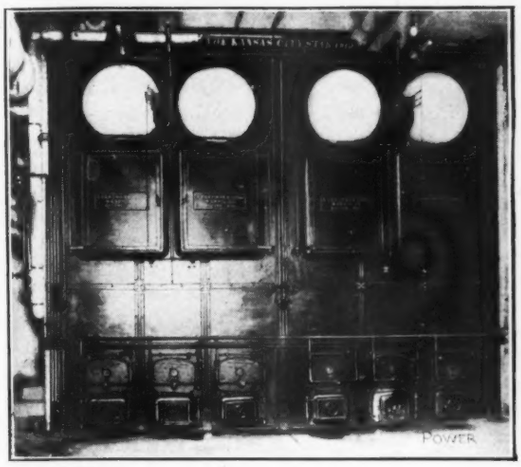


Fig. 2. Two of the Boilers

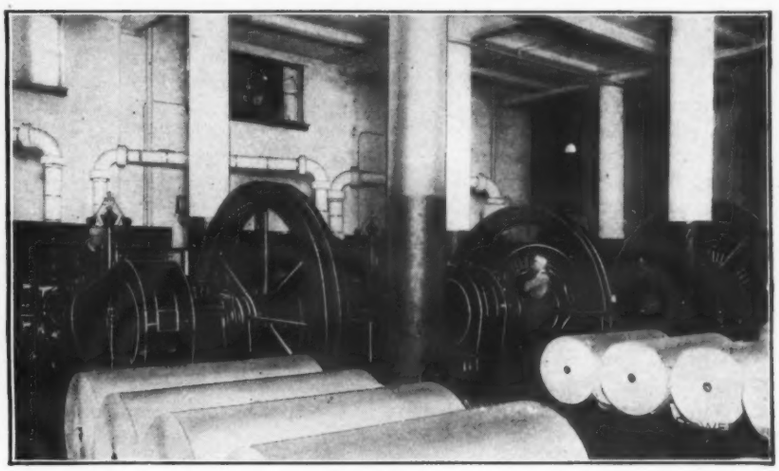


Fig. 3. The Engines and Generators

Ten hydraulic lifts handle the rolls of paper in receiving them from the delivery trucks in the street and raising them to the press-room floor from the storage room in the sub-basement. The water for these is pumped at 120 lb. by two Burnham simplex pumps with 10x20-in. water ends and 14 and 22 by 20 in. tandem compound steam ends.

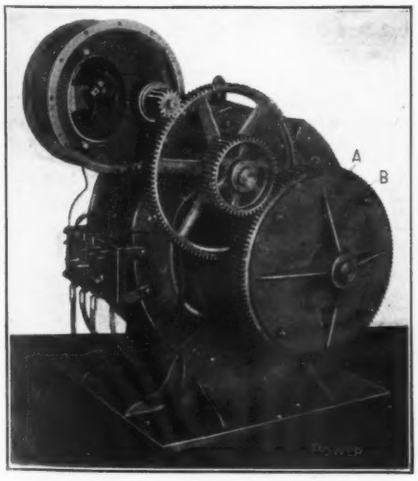


Fig. 4. One of the Press-operating Motors

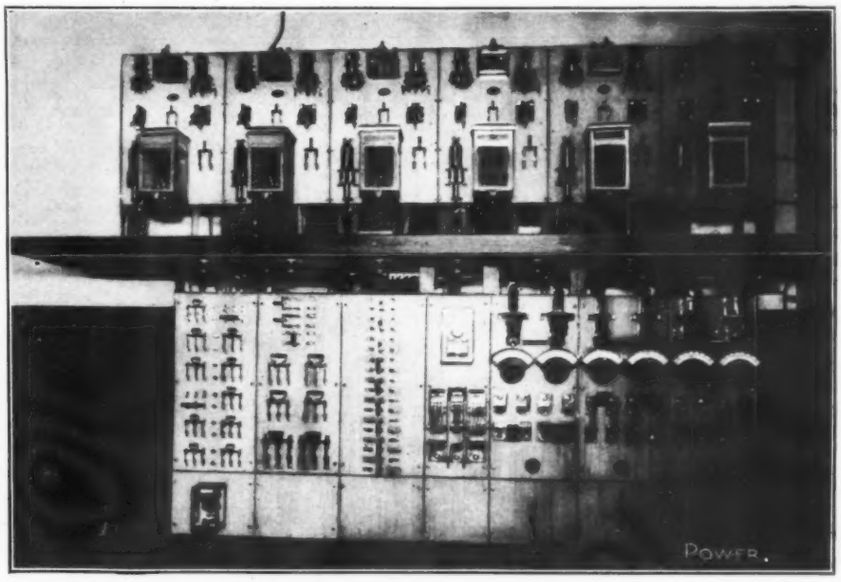


Fig. 5. The Main Switchboard

Generating Equipment

Three Westinghouse generators, Fig. 3, supply direct-current at 220 volts. Two are of 200 kw. and the third is of 300 kw. capacity. They are driven by H. N. Strait Manufacturing Co.'s Monarch

Corliss double-eccentric simple engines, running at 95 r.p.m. The two smaller engines are 18x36 in. and the large one is 20x8 in.

There are nearly 100 motors throughout the building of capacities from ¼ to 60 hp. which with the equipment of electric lights, constitute the load for the dynamos.

Electric Drive for Presses

The most important and most interesting motors are those which drive the presses. They have the Jenney system of control and were furnished by the American Rotary Valve Co. The equipment for each press includes two motors, one of 60-hp. for driving the press when printing an edition and one of 7½-hp. for operating at a very slow speed when "making-ready."

The chief reason for using two motors is safety, and a secondary object is economy. When a man is threading the "web" through the press it must run very slow and its speed not increase accidentally or otherwise until he can get clear. Likewise, when he is adjusting a plate, the press cannot be operated until he is finished.

The smaller motor is mounted on the frame of the larger, as shown in Fig. 4. The large motor is coupled directly to the main driving shaft of the press. A special clutch is connected with the small motor through gears as shown. The outer part *A* of the clutch carries the gear teeth which mesh with the gears of the small motor, and rides loosely on the shaft of the large motor. The inner face of the rim which carries these gear teeth has ratchet teeth. The inner portion *B* of the clutch consisting of a disk carrying a set of dogs, is rigidly fixed to the shaft of the large motor.

The dogs are pressed out by springs so as to engage the ratchet teeth of the rim *A* when the large motor is not being operated. Thus, closing the circuit of the small motor causes it to drive the press through the gears and clutch. The dogs are counterweighted so that when the large motor picks up the load and attains a slightly higher speed than that at which the small motor drives the clutch, centrifugal force, acting on the counterweights, throws the dogs clear and the small motor with its gears becomes entirely disconnected.

At various convenient points about the press are several push-button control boxes from which the slow-motion motor may be started or the press may be stopped. Each of these boxes also contains a positive disconnecting switch so that, when one of these switches is opened, the press cannot be started from any other box. This prevents a man being caught while working in an otherwise dangerous position. In addition to these boxes there is one main box from which the running speeds are controlled. This box contains an "increase"- and a "decrease"-speed button which operate a contact drum for cutting the resistance of the main motor in or out. This drum is driven by a small motor through reducing gears, the small motor being controlled by the push-buttons just mentioned.

Main Switchboard

The main switchboard, Fig. 5, is in two tiers. The upper set of panels carries the press-motor controllers, switches, and circuit breakers. Of the lower set, three panels carry the usual equipment of switches, circuit-breakers, and instruments for the dynamos. A fourth panel carries a wattmeter for measuring the total current consumption and the three remaining panels carry the switches for the various light and power circuits. A second wattmeter, on the lower part of the left end panel, measures the current used for lighting; the light and power circuits are separate. Thus, by subtracting the current used for the lights from the reading of the main wattmeter, the motor current consumption can be obtained.

Steam Header

The leads from the boilers collect into a 12-in. main steam header extending along the wall dividing the upper part of the boiler room from the engine room. From this the lines to the engines extend through the wall and connect with the several units as shown in Fig. 3. This header is so fitted with valves that any section can be cut out for repairs, or parts of the engine and boiler equipment can be isolated for testing purposes.

A National Biscuit Company Plant

Brief description of a small plant which possesses ideal working conditions. A scheme for pipe identification by different colors is worked out to good advantage.

The Kansas City plant of the National Biscuit Co. is one of the newest and best equipped of the numerous plants that this company operates. It contains the latest improved machinery for mixing, rolling and cutting the various cracker and cake doughs, for conveying and packing the finished products and for folding, wrapping and pasting the cartons in which the products are packed. As would naturally be expected of a plant devoted to the making of food products, the building is light, well ventilated and scrupulously clean throughout.

These characteristics extend even to the power plant which is contained in the low one-story addition at the right end of the building, as seen in Fig. 1. The power equipment is small, its arrangement is simple, and hence its story is quickly told, but it deserves attention here because it represents almost ideal conditions from the standpoints of both economical operation and the physical comfort and welfare of the working force. To begin with, crude oil is used as fuel, a circumstance contributing to both of the last-mentioned conditions, and to the general cleanliness of the plant as a whole. The wall facing the boilers contains large windows, an ample double door opens at the middle and, as the boiler and engine-room floor level is but a few feet below the street, plenty of light and air is admitted. In the engine room large windows on two sides afford ample light and ventilation there also.

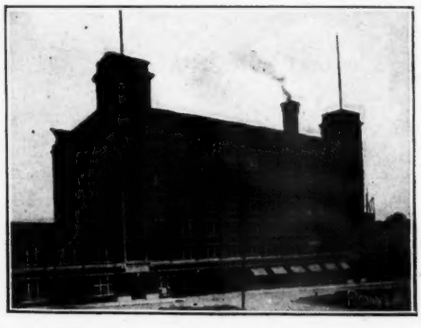


Fig. 1. Kansas City Plant of National Biscuit Co.

A view in the boiler room is given in Fig. 2. Steam is generated in two B. & W. water-tube boilers of 265 hp. each, fitted with the Hammel back-shot oil-burning system. Steam is carried at 110 lb. pressure. Two underground steel tanks outside of the plant store the fuel oil. Their combined capacity is 30,000 gal. The feed water is heated in a Stillwell 500-hp. open heater. The two feed pumps are Wilson-Snyder horizontal duplex plunger pumps, one 5x3½x8-in. and the other 7x4x12-in. A Marsh vertical deep-well pump with a 5x24-in. water end raises water from a well to the ammonia condenser of the refrigerating system. On the heating system is a Wilson-Snyder simplex 8x10x12-in. vacuum-return pump.

In the engine room are two generating units, an air compressor and one engine-driven and two motor-driven exciters. The main unit is an 18x36-in. Allis-Chalmers Corliss engine driving a Westinghouse

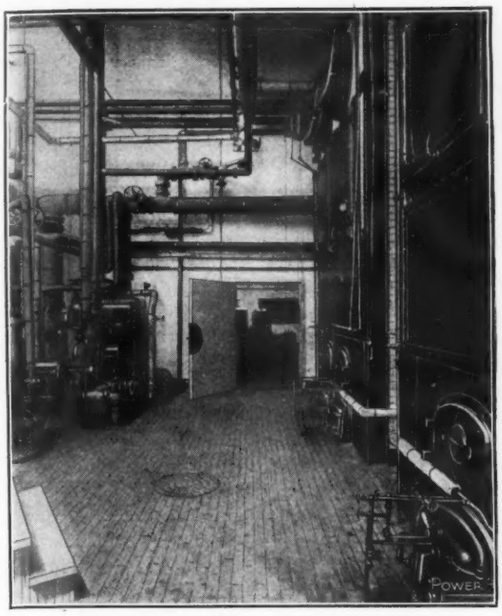


FIG. 2. THE BOILERS, PUMPS AND HEATER

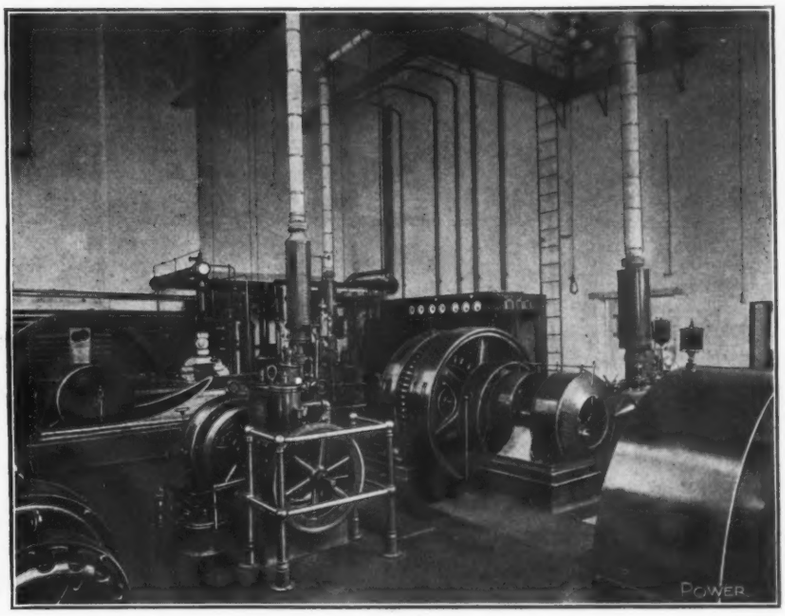


FIG. 3. PART OF THE GENERATING EQUIPMENT AND THE ICE MACHINE

200-kw. alternating-current generator. The current is generated at 220 volts and is two-phase, 60-cycle. This unit runs at 121 r.p.m. The other main generating unit is a Buckeye piston-valve engine, running at 257 r.p.m., driving a 100-kw. Westinghouse dynamo. Throughout the building are 66 motors, ranging from ½ to 15 hp. A small two-cylinder simple-acting vertical Westinghouse high-speed engine, running at 400 r.p.m., drives a 16-kw. exciter used when starting up. After the plant is started, excitation is furnished by either of the two motor-driven exciters, one of which is of 10 kw. and the other 15 kw. capacity.

The ammonia compressor, of 20 tons capacity, is a Linde, driven by an Ohio Corliss 12x30-in. engine at a maximum speed of 65 r.p.m. Cold brine is piped through the building to various cold boxes used for storing eggs, milk, butter, etc., by two Laidlaw-Dunn-Gordon 4½x6x6-in. duplex pumps.

The sponge, or proving room, where the biscuits are placed to raise, is maintained at or very close to 80 deg. F. all the time. On some days during the summer this requires artificially cooled air. To get as close regulation as possible, air is circulated through either a heating or a cooling chamber, as required, and delivered into the room by a Sturtevant ventilating fan. A thermostat in the room automatically controls the fan and the dampers.

PIPING

From each boiler an 8-in. lead connects into a short 12-in. header which extends through the engine-room wall and then branches each way, as shown in Fig. 3. A short separate auxiliary header supplies steam to the pumps and other auxiliaries.

Ready identification of the different piping throughout the plant is afforded by painting each system a distinguishing color: white, live or high-pressure steam; brown, exhaust or low-pressure steam; green, hot water; red, fire system; orange, cold-water service; yellow, gas, and black, sewer. By this means it is possible to tell instantly what a given pipe contains and thus mistakes may be avoided and time saved in tracing out the various lines.

Over the Spillway

Out in Beach City, Ohio, a fond mother bought her son a power plant as a "place to show his skill and keep busy." Friend son was recently graduated from an engineering school. Of course, he'll keep busy. And if your skill short-circuits, sonny, blame it on the plant, and perhaps mother will buy you a nice new one.

Hex Nutt, employed in the Holdfast (Tex.) power plant, who has been suffering from a severe wrench, took a bad turn on Tuesday.

B. T. Unit, night engineer at the Holy Terror (N. D.) pumping station, has added another Unit to his battery of five. It's a boy. "Brit" says the youngster will probably be named after the town of his birth.

A contemporary apologizes for a typographical error in its article on transmitting capacities of pulleys. As pulleys appeared as "pullets," the printer evidently thought the publisher was advancing a new theory of eugenics for raising chickens.

Poor Draft! Everybody seems to mourn his loss. Draft had a wide acquaintance among operating engineers and was a near connection of the well known Stack and Furnace families of Plantville.

Ig. Nition is back firing at the gas plant. Ig. is some het up over the rumor that his absence was due to carrying an improper mixture.

An Oregon civil engineer is real peeved because the word "engineer" confounds him with the operating engineer, whom he terms the "monkey-wrench man," the "starter and stopper." He would just dote on being called an "energier"—just like that. Perhaps if the operating engineer changed his designation to "monkey-wrencher," "stopperette" or "starterino," the more or less civil engineer would be content.

Hard Coale, fireman at the Asheville (N. C.) Soap Works plant, has been discharged for paying more attention to his "suds" than his scoop.

Carrie Sene has put the kibosh on young Brush's sparking and chattering. We are indebted to Carrie for cleaning up several little difficulties in our midst.

T. Crane has a fine position traveling back and forth for Lift & Haulem.

Hen Dill, engineer of the coal barge "Pickel," is dead set on finding the party who put the missis in the Mississippi. Hen's missis, Daffie Dill, being considerable hefty, is afraid the government is going to hold her liable for bursting the levee near where she went in.

Electrical Department

Conducted to be of service to the men in charge of electrical equipment in the power house

Inspecting and Testing Electrical Apparatus—III

By A. L. Cook

Inspecting Switchboard Instruments

The switchboard instruments usually furnished with an alternating-current generator, are one or more ammeters, a voltmeter, wattmeter and sometimes a power-factor meter. The readings of these instruments should be compared to detect any serious inaccuracies. If there are two voltmeters, they may be compared when connected on the same circuit, or checked with a portable meter known to be correct. The generator ammeters can be checked with the sum of the feeder-ammeter readings on any one phase. This should equal the reading of the generator ammeter if only one machine is in operation, but with two or more generators in parallel, there will be cross-currents between the machines and the generator ammeters will read higher. Generator wattmeters usually indicate the total output of the machine in kilowatts. Sometimes two single-phase wattmeters are used for a polyphase generator, in which case the sum of the readings would, in general, indicate the total output; the only exception is with three-phase generators where the power factor is less than 0.50, in which case the smaller reading must be subtracted from the larger. The wattmeter can be checked approximately by assuming a power factor; that is, the ratio of actual watts to volts × amperes. For lighting service only, this would be about 0.90 and where a large number of induction motors are used, about 0.80. For a single-phase generator the kilowatt output would be:

$$\text{Kilowatts} = \frac{\text{Volts} \times \text{Amperes} \times \text{Power-factor}}{1{,}000}$$

For a three-phase generator:

$$\text{Kilowatts} = \frac{\text{Volts} \times \text{Amperes} \times \text{Power-factor} \times \sqrt{3}}{1{,}000}$$

For a two-phase generator:

$$\text{Kilowatts} = \frac{\text{Volts} \times \text{Amperes} \times \text{Power-factor} \times 2}{1{,}000}$$

In each case the voltage is that of any phase and the amperes is the current in any lead, assuming a balanced system. The last equation applies to a four-wire two-phase system. For a three-wire two-phase system, the current to be used in the equation is that in either outside wire, and the voltage is that between either outside wire and the common wire.

The power-factor meter can be compared with the wattmeter by substituting its readings in the foregoing equations and solving for the kilowatts, which should equal the readings of the wattmeter.

Watt-hour meters are generally furnished either for the generators or the feeders to record the total output in kilowatt-hours. These meters should be checked to see that the front edge of the disk rotates in the proper direction. Sometimes it will be found that the reading of a polyphase wattmeter or the speed of a polyphase watt-hour meter, when connected to a generator will change when the field rheostat is adjusted with no change in load on the generator. This is due to the potential and current coils being connected to the wrong phases.

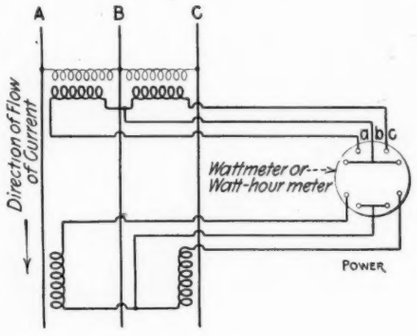


Fig. 8. Wattmeter Connections for Three-phase System

These meters really consist of two single-phase wattmeter elements assembled on the same shaft. Before checking the wattmeter connections it is necessary to determine the voltage and current terminals corresponding to each set of elements. Usually this may be done by inspection, but if this is not possible, a simple test will determine the proper connections. With both current coils connected and load on the meter, one pair of voltage terminals should be disconnected. The meter should deflect or the disk rotate. First one pair of current terminals and then the other should be short-circuited. The pair which when short-circuited causes the pointer to return to zero or the rotation to cease is connected to the element corresponding to the voltage coil in service, and the terminals should be marked accordingly.

Having determined this, the connection to the current and potential transformers should be checked; Fig. 8 gives connections for a polyphase meter in a three-phase circuit and Fig. 9, similar connections for a two-phase circuit. The top pair of meter terminals on each side are connected to the voltage coils and the lower pairs to the current coils, the corresponding sets being on the right and left respectively. In Fig. 8 the current terminals of one element are connected in lead *A* while the corresponding voltage terminals are connected between this lead and that which has no current transformer. In Fig. 9, the voltage and current terminals of one element are connected in phase A_1A_2 and the other in phase B_1B_2. Generally the connections between the instrument transformers and the meter can be traced, as they should have been tagged when installed, but if for any reason it is desired to make a test to insure that the corresponding voltage and current terminals are connected

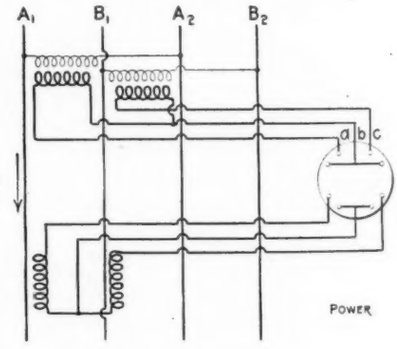


Fig. 9. Wattmeter Connections for Two-phase Four-wire System

to the transformers on the same phase this may be done as follows:

The common wires for both the voltage and the current transformers should first be traced out and connected to the proper terminals of the meter; then the other wires may be connected to the remaining terminals. The meter should now operate if there is load on the circuit. One of the outside voltage leads, such as *a*, Fig. 8, should be opened at the transformer, and the current transformer in phase *A* short-circuited. If the meter reads zero it is an indication that the current and voltage leads of phase *A* are connected to the same element, which is correct. If the meter does not return to zero the connections are wrong and volt-

age leads *a* and *c* should be interchanged at the meter.

Having connected corresponding voltage and current leads to the same meter element, it is necessary to check the polarity. With load on the machine, one of the outside voltage leads (for example *a*) should be removed from the meter. The instrument should deflect properly or the rotation should be in a forward direction. If the wrong deflection is indicated, the two voltage leads connected to the element in service should be reversed. Lead *a* should then be replaced and lead *c* disconnected. The meter should still deflect correctly and if not the voltage leads in service should be interchanged. Generally it will be found that the deflection when one side of the meter is disconnected is different from that when the other side is out of service. The readings would only be alike when the power factor is 100 per cent. and this very seldom occurs in practice. At 50 per cent. power factor, one side will not deflect at all and for lower power factors this side will give a reversed reading; hence the foregoing rule for checking polarity applies only to a power factor greater than 50 per cent. Since most systems have power factors between 70 and 90 per cent., however, this rule is generally correct. In dealing with current transformers, the secondary circuit should never be opened when current is flowing in the main leads as a very high and sometimes dangerous potential in the instrument circuit may result, and if the circuit is left open for a considerable length of time the transformer will become overheated and probably burn out.

Most modern alternating-current plants are equipped with a Tirril voltage regulator which automatically maintains normal voltage on the busbars under all conditions of load by varying the exciter voltage. This regulator is carefully adjusted at the factory and usually requires very little attention to put in service. The manufacturers always furnish a diagram of connections together with complete instructions for installing and operating and it would be outside the scope of this article to give such instructions. While the instruction book gives complete directions for adjusting the various parts, it is seldom necessary to do this as each regulator is carefully adjusted at the factory. The adjustment is a rather delicate operation and should not be attempted unless one is familiar with the apparatus. Certain tests should be made, however, before the regulator is put in service, and these will be outlined briefly.

Tests should first be made to determine the proper setting for the exciter field rheostat and it can then be sectionalized and connected to the relay contacts on the regulator. After the regulator has been connected up, cleaned, and the moving parts inspected to see that they move freely, the dashpot may be filled with oil and the counterweight adjusted to balance with normal alternating-current voltage on the regulator. During this operation, the switches connecting the regulator with the exciter field rheostat should be open and the regulator lever balanced until the main contacts just close at a voltage about 2 per cent. less than normal. The generator field rheostat is generally all cut out when operating with a voltage regulator, unless the voltage across the field of the generator is less than 70 volts with no load. A test should be made to determine this, and if necessary, sufficient resistance should be left in the generator field rheostat so as to give 70 volts under these conditions. After this has been determined, the regulator can be put in service according to the instructions. The alternating-current voltage should then be adjusted until it is exactly normal.

Ordinarily the regulator is used to maintain a constant potential at the busbars for all loads, but if it is compounded, this adjustment should be checked and corrected if necessary. When the generators are operating at not more than full load, the regulator relay contacts should vibrate rapidly, the rate being highest at light loads. The regulator should need no further adjustment until the contacts become worn.

Transmission Notes

General practice in transmission systems is discussed to some length in a report presented at the recent convention of the Ohio Electric Light Association. It says, "The practical working radius of 2300-volt transmission is very limited and under ordinary conditions is about one mile for 25 cycles and ¾ mile for 60 cycles when the wire is loaded to its full current carrying capacity, with a 10 per cent. drop in voltage." For higher voltages the report recommends, as a good rule, 1000 volts per mile of line.

Regarding the spacing of conductors it specifies the following:

	Spacing, Inches	
Volts	Minimum	Maximum
6600	12	48
13200	18	36
22000	30	36
33000	32	72

The arrangement of conductors is either triangular or all in one plane for three-phase distribution, the former being preferable, owing to the balanced inductive effect.

As to the choice between aluminum and copper conductors the report says: "For equal transmission conditions, the cost of an aluminum line is about equal to that of copper when the aluminum sells at about 2.1 times the price of copper. Aluminum, however, must be handled more carefully and it has greater expansion and more sag, which in turn requires greater spacing between wires, and this raises the reactance of the line."

In discussing lightning protection it says:

"Lightning protection is at all times necessary. The more ways in which the lightning is taken care of, the greater is the possibility of uninterrupted service. Of the numerous arresters the two most prominent are the multigap and the aluminum cell. The most effective mechanical means of preventing lightning disturbance is the overhead ground wire. The aluminum cell arrester has proved very efficient, as it not only affords a path to ground for lightning but aids in removing all internal line disturbances. It is used for excessive voltages and is adaptable for almost any voltage. However, this arrester has a disadvantage in that it is necessary to charge it each day; in this way the efficiency of the arrester is dependent upon the station operator. The multigap arrester also has the feature of relieving surges and is found very efficient for voltages up to 13,200. The ground wire is best placed at the top of the structure so that it has a shade angle of 45 deg. to the outside conductors. It is best constructed of ⅜-in. stranded galvanized plow steel or bimetallic wire. The ideal construction for overcoming the dangerous effects of lightning is the placing of the ground wires at the highest point of the poles and also placing aluminum cell arresters at both ends of the line and in the center."

In discussing this phase of the report, Prof. F. C. Caldwell, of the Ohio State University, made some interesting observations. He attributed the failure of lightning arresters to prevent discharges from the line in their immediate vicinity, to the presence of nodes or points of no vibration in the line. To illustrate this point he drew comparison with the vibration of a string of a musical instrument; the string may vibrate as a whole, the greatest vibration occurring in the middle, or it may vibrate in two parts, in which case there is a point of no vibration at the middle. In this case the string may be held at the middle without affecting the vibration. Similarly, if the lightning arrester is placed at one of the nodes on the transmission line there may be no tendency for a discharge through it, although high potentials and discharges may develop at a comparatively short distance from it.

The one difficulty, as pointed out by Prof. Caldwell, is in determining the probable location of these nodes so that the arresters may be placed accordingly. However, if inductance is inserted in the line by the introduction of a solenoid, and several gaps are tapped along the coil, the probability of all the gaps coming at nodes will be very small, especially as each turn would correspond to a considerable length of line in its effect on the wave of lightning discharge.

A 2400-Volt Direct-Current System

According to recent advices, a contract has just been closed for the electrification of the Butte, Anaconda & Pacific Ry. with a 2400-volt direct-current system. Power will be supplied by the Great Falls Power Co. over a three-phase, 60-cycle, 50,000-volt transmission line to two substations, one at Butte and the other at Anaconda, 26 miles apart. At the substations the voltage is to be stepped down to 2300 volts at which potential the current will be supplied to synchronous motor-generator sets, each consisting of two 1200-volt compound-wound commutating-pole direct-current generators and one 2300-volt, three-phase, synchronous motor. The generators will be arranged to operate in series to supply 2400 volts to the trolley wire.

The entire equipment is to be furnished by the General Electric Co.

CORRESPONDENCE

Pilot Lamps

In the June 25 issue, Mr. Chamberlain suggests that, to avoid absolute darkness in an engine room when the machine breakers blow on the generators at night, one or two of the lamps on the switchboard be connected directly to the generator leads and inside of the breakers. With this arrangement, so long as the generators can supply current at even a low voltage, there will be light.

While such an arrangement is a great improvement over the plan of having no light in such an emergency, it would be still better to be able to have light even if the generator itself should fail, or, where all of the current is obtained from outside sources, as in a rotary converter substation, if the feeder from the power station should break down.

The only ways to do this are to have a second source of current, such as a storage battery, with a breakdown connection, or to keep a lantern lighted after dark. It may be objected that oil lanterns around an electric plant are out-of-date, but they will be found always ready for use in some of the largest power stations. They are always turned low so that they require little oil or attention, but can always be found and used in an instant.

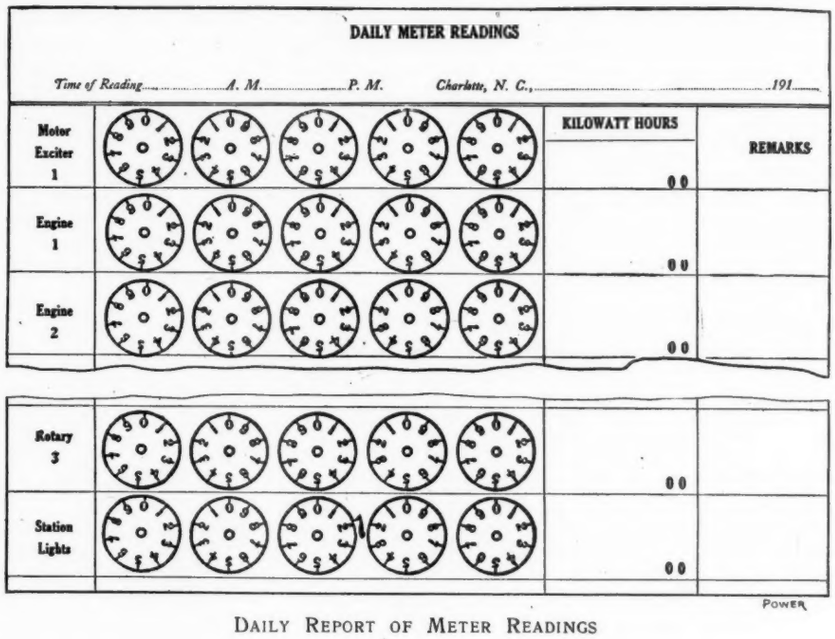
If the pilot lamps are used, they should not be "tied in solid" to the generator leads, but a switch and fuse should always be between the lamps and the source of power. Then, in case of trouble on the wiring to these lamps, they will be cleared by the blowing of the fuse, and a short-circuit will not mean losing all the wiring. Without the fuse, there is also danger of fire, if the circuit should become crossed; an installation of the wiring without it would not be approved by the fire underwriters.

G. H. McKELWAY.

Brooklyn, N. Y.

Correct Meter Readings

After experiencing considerable trouble in obtaining correct meter readings, due to errors in taking them and also in transferring them to the log sheets, I had the accompanying form printed. The operators now read each meter by marking the proper dials and the sheets are bound into the daily report.


DAILY METER READINGS

Time of Reading..... A. M..... P. M. Charlotte, N. C., ... 191....

		KILOWATT HOURS	REMARKS
Motor Exciter 1		00	
Engine 1		00	
Engine 2		00	
Rotary 3		00	
Station Lights		00	

POWER

DAILY REPORT OF METER READINGS

J. B. LINKER.

Charlotte, N. C.

Heating of Storage Batteries

I read with interest that part of the "Catechism of Electricity" dealing with storage batteries, in the issue of June 4. Their ventilation, the lighting of the room, and also the location of the room were discussed, but I failed to find anything on cooling the battery while charging.

I have had considerable experience with storage batteries, and one of the greatest difficulties has been to overcome the excessive heating while charging. This was finally accomplished, however, in the following way: I made a wooden tank large enough so that the battery (in hard rubber jars) could be set into the tank and a stream of running water be allowed to circulate around the jars, and run off at the opposite end of the tank, the surface of the water coming to within 1 in. of the top of the jars.

I used this system of cooling through the hot weather last summer, and am using it now. Although the battery has been charged at an exceedingly high rate, I have never known the temperature to go higher than 80 deg. F.

F. C. HEATHER.

Sterling, Colo.

Sparking Brushes

Carbon brushes are generally rather hard, and when in contact with copper commutator segments, cutting or grinding is likely to occur if close attention is not given. If too tight they will cut down the commutator and soon wear it out; if too loose sparking will result.

I had trouble of this kind and to get satisfactory service had to turn down the commutator about once a week. New armature segments were put in but did not help much and soon these were nearly gone.

After trying several suggestions without success, I finally turned down the commutator to a smooth finish and cut the brushes so that the holders fitted close to the commutator without too much tension in the springs. On account of the segments being narrower after being worn down it was necessary to have the brushes thinner, so I filed each brush off $\frac{1}{32}$ in. on both sides for about $\frac{1}{2}$ in. back. After bringing each brush to true alignment perfect commutation resulted and no trouble was experienced in maintaining the voltage. Each morning after shutting down I take off the brushes and leave them in kerosene and graphite all day. This seems to make them softer. If the brush is very long it is likely to wear sideways or get out of alignment axially. If short it is held more securely in place with less tension in the spring.

WILLIAM E. MILLER.

Jackson, Tenn.

Gas Power Department

Worth-while gas-engine and producer information treated in a way that can be of practical use

Gas Engine Valve Setting

By Olaf Olafsen

Were the true Otto cycle possible the following would be the order of events: First stroke—from inner dead center to outer dead center, suction stroke. Second stroke—from the outer dead center to inner dead center, returning, compression stroke. Third stroke—from inner dead center to outer dead center, power stroke. Fourth stroke—from outer dead center to inner dead center, returning, exhaust stroke. The cycle is then completed.

First consider the exhaust. To allow the pressure to fall to atmospheric before the piston starts on the return stroke and to insure sufficient valve opening to avoid back pressure, it is necessary that the exhaust valve open before the end of the power stroke. In most engines the release takes place about 45 deg. before the outer center is reached or 45 deg. "early." Any exhaust may start 30 deg. early, however, without losing power. Fig. 1 is a diagram from an engine of well known make with release taking place 60 deg. early. Fig. 2 is a diagram taken from the same engine with an indicator having a light spring and a stop to avoid breaking the pencil motion. The scale in this case was 6 lb. per inch as against 240 lb. with the first diagram. Fig. 3 shows a light spring diagram from an oil engine with the exhaust valve opening 45 deg. early. In each case the fall of pressure to atmospheric is completed very nearly at the end of the stroke, which is proper, showing no loss of available expansion and no back pressure.

Certain four-stroke-cycle engines have an exhaust port through the cylinder wall, which is uncovered by the piston at the end of the stroke. This leaves a comparatively small volume to pass the poppet valve, relieving the valve-gear of the strain of opening under pressure and adding to the life of the valve and seat. In these engines it is customary to open the valve on the outer dead center to let the fall of pressure take place through the side port. These side ports are uncovered at about 30 deg. early by one builder. The time of opening will depend upon the speed of the engine, the area of port and the relation of width to length of port just as the valve timing will be determined by the size and lift of the valve, size of ports and layout of lifting cam. The valve lift must be nearly proportional to the piston velocity at various parts of the stroke, or the outlet may be ample at mid-stroke and restricted at the ends even though the valves, ports and valve lifts are correct. So much is to be found in the better works on engine design concerning cam layouts, port areas and valve sizes that these details will here be omitted.

Where the exhaust piping provides free exhaust but is not too short, the burnt gases, upon being released, rush out through the pipe with high velocity, due

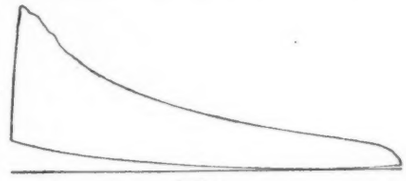


FIG. 1

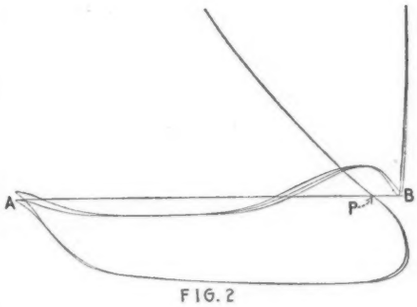


FIG. 2

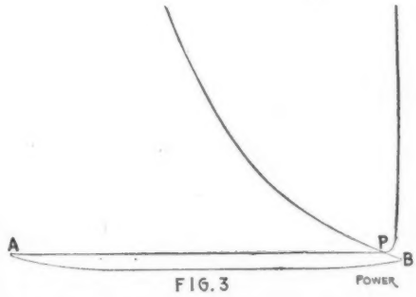


FIG. 3

Upper Diagram Taken with Heavy Spring, and Lower Diagrams with Light Spring

to momentum, and continue to travel even after the pressure in the cylinder has been relieved. This plug of exhaust gas has an effect upon the cylinder like a long piston drawn through the exhaust pipe. This is plainly shown in Fig. 3 where the exhaust line falls below the atmospheric line. It did not take place in Fig. 2 because two three-cylinder engines of large size were exhausting into the same main at the time the diagram was taken. Advantage is taken of this phenomenon as follows: The exhaust valve is not closed on the inner dead center but is held open for 10 or 15 deg. late. The inlet is opened on the same cylinder 10 or 15 deg. early or before the dead center is reached. There is then a period of 20 or 30 deg. during which the exhaust gases draw fresh air through the clearance, more or less completely scavenging it, depending on the position of the valves and the perfection of the action. On engines having timed gas admission, it is safe to allow an overlap of 30 deg., as no loss of fuel can take place, and 20 deg. lap may be used without waste of mixture on engines employing some form of simultaneous admission of gas to air unless both valves should be located in one small pocket on one side of the cylinder.

Certain conditions arise which sometimes make it impossible to make use of the foregoing. Automobile motors are usually muffled and under some back pressure; also, multicylinder engines having more than three cylinders exhausting into one pipe must close the exhaust before the inlet is opened to avoid the exhaust blowing back from one cylinder into another. In spite of the danger it will be found advantageous on high-speed engines to hold the exhaust open a short time after passing center and open the inlet still later to insure as much reduction of pressure in the cylinder as possible.

Three- or six-cylinder stationary engines with two or more exhaust pipes make it possible to utilize such action very nicely. Three exhaust periods must be completed in two revolutions giving 240 deg. for each exhaust. Taking 180 deg. for the theoretical exhaust stroke and 10 deg. for overtravel, there remains 50 deg. for lead, and the few degrees of pause between exhaust from the different cylinders to insure the closure of one exhaust port before opening the other. Moreover, where the gas is rich in hydrogen and easily inflamed or where the gases are very slow burning and linger in pockets serious backfiring may result if the mixture is drawn into the clearance before the exhaust is complete.

Where the valves are so placed as to insure scavenging and where the fuel or other conditions do not introduce difficulties a decided gain in power results from proper application of the foregoing.

On heavy engines having valves operated by wiper cams and eccentrics it is found advisable to sacrifice some rapid-

ity of opening and closing in order to overcome the inertia and hammering of the valves. In this case it may be necessary to open earlier and close later than usual. These motions give very rapid travel during mid-stroke, but raise and seat the valves very gently. It is usually possible to employ a timing with lap of valve openings on these large tandem double-acting engines even when there are four working ends, as the length of pipe between each valve and the underground main is considerable. Twin tandem engines usually have two mains.

With present piston speeds it is impossible or at least impracticable to make the valves and ports of such size that the gases will be able to keep the cylinder filled during the suction stroke at atmospheric pressure; hence at the end of the theoretical suction stroke the pressure in the cylinder is somewhat below atmospheric. However, as the gases are traveling through the ports at high velocity the combined effect of their inertia and the partial vacuum in the cylinder will allow the filling process to continue even after the piston starts on its return stroke.

In stationary engines of good design the inlet may be held open for 20 to 30 deg. beyond dead center without loss of charge. On old engines where the cams are improperly laid out or the valves and ports inadequate they may be held open as late as 60 deg. without loss, although it is true that such an engine will fall short in power as full cylinder displacement is not effective.

In Fig. 1 the suction drop does not show as the spring is too stiff to indicate much movement under such low pressures, but Fig. 2 from the same engine with a light spring and stop illustrates this very well. These diagrams are from an old engine with automatic inlet valves. The suction is expressive, although it is desirable to allow more drop to take place with automatic inlets than with mechanically operated valves to insure prompt opening and closing of the valves.

Fig. 3 shows a very good suction line and was taken from a larger engine with cam-operated inlet valves opening 10 deg. early and closing 30 deg. late.

Referring to *P* where the compression line crosses the atmospheric line on Figs. 2 and 3, it is obvious that the ratio of *AP* to *AB* will be an index to the volumetric efficiency. In taking such diagrams care must be exercised in handling the indicator, the piston and cylinder of which must be free from grit and be frequently oiled. There must be no appreciable lost motion in the pencil motion or the diagrams will be useless.

The foregoing theories will hold true with the addition of some thought and common sense applied to individual cases by the man on the job. Above all, when the valve travel is found to be too short in period, take up all lost motion in the linkage except what little clearance is necessary to insure closure of the valve, thus getting all the available travel, and then shift the gears so that the exhaust does not close before the dead center but do not try to get too much overtravel at the expense of the release. Likewise the inlet should not close before the outer dead center is reached, even at the expense of opening a trifle late. On high-speed engines the inlet should have some overtravel (late closure) if the valve motion will permit. In any case the closure is the important point when conditions cannot be altered to give the desired valve setting. Unless one is sure of his ground, it is preferable to make the best of what settings can be had from a well adjusted valve-gear in good repair than to attempt changes in linkage, cams or rollers.

Builders often furnish typical diagrams, but it is not always possible to duplicate these, because of backlash of the gears, slight differences in or wear of cams, collers or links. However, it is usually possible to comply with the sample diagram within 3 deg. on either side at closure and let the openings come as nearly right as they may. When the valve-gear is operated by a train of spur and bevel gears and shifting one tooth of one gear advances or delays the events too much, if there are pairs of gears of different pitches or different numbers of teeth on any of the connecting shafts, by shifting one pair of coarse pitch or large size ahead one tooth and a pair of finer pitch or smaller size back one tooth at the same time, or *vice versa*, the desired setting may be obtained.

On engines that have separate cam-operated inlet valves, such as the Otto (Columbia type), Fox, Callahan, White and Middleton, the inlet should not open until after passing dead center (not earlier than 10 deg. late, nor later than 30 deg. after center), when the exhaust is closed to avoid backfiring and loss of fuel. These should close on center with automatic intakes. On small engines they often close as late as 30 deg. after or as early as 30 deg. before dead center. The later setting seems preferable, but the charge seems to mix on compression stroke and no bad results occur with the early closure. In fact, one of the most economical small city gas engines on the market today by actual test closes the fuel inlet 30 deg. early while another of equal rank closes it 28 deg. late.

On suction-gas engines where the engine must draw its fuel through the produced bed and scrubber, the fuel valve-if separate, may be opened simultaneously with the inlet valve in order to start the gas toward the engine in good time. This applies particularly to single-cylinder hit-and-miss engines, a type now seldom used with producers in this country.

Fuel Economy of Gasoline Engines

By A. A. Potter

Gasoline-engine manufacturers usually claim that their engines will develop 1 hp. for 10 hr. on a gallon of gasoline. Believing that few operators are able to realize this economy on small engines tests were conducted at the Kansas State Agricultural College under the direction of the arthur on five gasoline engines of different makes, and varying in power from 1¾ to 10 hp., to determine the actual fuel economy per brake horsepower-hour under ordinary working conditions.

The engines tested were all of the four-stroke-cycle type, water cooled, governed by the hit-and-miss method and provided with a make-and-break ignition system. They were loaded by Prony brakes and the fuel was accurately weighed. Three to six check runs were made at each load, each lasting 30 min.

The gasoline used was 62 deg. Bé. and had a specific gravity of 0.731 at 60 deg. F., making the weight 6.09 lb. per gal. The heat of combustion of the gasoline, as determined by a Junkers constant-pressure calorimeter was 19,411 B.t.u. per lb. (high), or 18,415 B.t.u. per lb. net.

The average results of the tests are given in the table, from which it is evident that 1.3 to 1.69 gal. of gasoline will be required to run the average small engine 10 hr. at full load.

Tests by C. E. Lucke and C. M. Woodword (see Bulletin No. 191, U. S. Department of Agriculture) show an average of 0.25 gal. per b.hp.-hr. for a 2-hp. marine engine and 0.12 gal. for an 18-hp. engine.

FUEL ECONOMY OF GASOLENE ENGINES

Cylinder Diameter, inches	Stroke, inches	R.P.M.	Rated B.HP.	Gasolene Consumption per B.h.p.-hr.							
				Full Load		¾ Load		½ Load		¼ Load	
				Lb.	Gal.	Lb.	Gal.	Lb.	Gal.	Lb.	Gal.
3.5	5.25	500	1.75	1.030	0.169			1.35	0.222	1.99	0.327
5.0	8.0	350	4.0	0.915	0.150	1.03	0.169	1.24	0.204	2.08	0.342
5.5	9.0	325	6.0	0.834	0.137	0.81	0.133	0.99	0.163	1.47	0.242
6.5	9.5	300	6.0	0.855	0.140	1.06	0.174	1.14	0.187	1.61	0.264
7.25	14.0	250	10.	0.791	0.13			1.46	0.24		

Commercial Utilization of Peat for Power*

By H. V. Pegg

Utilizing peat commercially would seem to require as a first consideration using it, as nearly as possible in the condition in which it leaves the boglands without preliminary and expensive machine treatment.

About seven years ago the author experimented with air-dried hand-cut peat fired into a special form of gas producer. With all gas producers using bituminous coal the main trouble is to get rid of the tarry byproduct. In this instance the producer was arranged to work intermittently, with periods of "blowing" during which the fuel was brought to incandescence and periods of gas making during which the tarry byproducts were passed through the incandescent fuel and converted into gas. The chief difficulty with this plant was the high thermal value of the gas generated—about 330 B.t.u. Owing to the high and varying percentage of hydrogen, it proved unsuitable for the gas engine. Although the plant ran more or less continuously for ten days, considerable trouble was experienced, owing to the varying moisture content of the peat.

From this experience it seemed wiser to extract the tar, rather than try to convert it into gas; furthermore, the producer must not be sensitive to the moisture in the peat. Later various tests were run with an experimental plant at the works of Messrs. Crossley Bros. Portadown, and as a result of these, a special plant was built from their designs and patents and to the author's specification. This plant has been running since last September and has been described in the daily and technical press;* hence there is no need to dwell upon its details. However, a few of the difficulties experienced with it will be mentioned.

Air-dried peat is an inconvenient fuel to fire into a producer; therefore originally the peat was reduced in size to blocks of about 5-in. cube; but later it was found possible to dispense with this preliminary treatment, and the construction of the plant was thereby simplified.

Last October the plant was subjected to a test run of 6 hr. with a load of 250 b.hp., the peat consumption per b.hp.-hr. averaging 2.55 lb. and the peat fuel containing 18.98 per cent moisture; this was with both producers running, although the load was considerably below the total capacity of the plant. The low percentage of moisture was due to the unusually dry summer of 1911. During November and December, however, the fuel was extremely wet, but the plant worked just as well with the sodden peat as with the drier peat, the only difference being the amount consumed. The amount of water in this "sodden peat" varied considerably, being sometimes as high as 70 per cent.

The separation of the tar from the gas was the chief difficulty, and it was found far better to rely on an ample water-spray through which the gas passed than upon any form of coke scrubber. The large part of the tar was thrown out into a tar sump by a centrifugal tar extractor; but unless the gases were subjected to a thorough washing and cooling by the water-spray, some tar got past the extractor, collected in the gas mains and finally reached the engines.

When first started, the plant in general, and especially the producers, required thorough cleaning once a week, but at present it can be run if necessary for three weeks without cleaning, although cleaned weekly as a matter of precaution. This is owing to the increased washing water used, which is now about 7 gal. per b.hp.-hr. The tar recovered is about 5 per cent. of the weight of peat consumed.

Experiments were made in burning the tar under boilers, but owing to the high percentage of water present and the large quantity of solid matter, considerable preliminary treatment was necessary. For a time the tar at Portadown was mixed with coal and burned under a Stirling boiler, but now the whole factory is run entirely on peat fuel, the consumption being about 44 tons per week, of which the producer plant takes about 22 tons.

The plant is of 400 hp. capacity and up to June of this year the use of peat has shown an average weekly saving of about $80 over periods of similar operation when using coal.

*Excerpt from paper read at the Belfast meeting of the Institution of Mechanical Engineers, July, 1912.

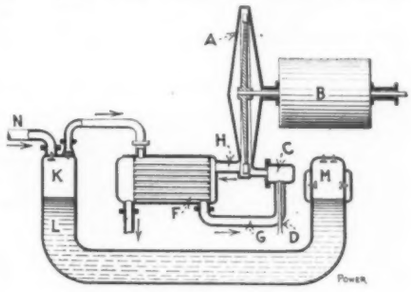
*See Power, Jan. 23 and May 7, 1912.

Gas Turbine

Engineering mentions a patent issued to Brown, Boveri & Co., Baden, Switzerland, for a gas turbine. According to the processes heretofore proposed for working gas turbines, the preliminary compression of the motive medium is effected in piston or revolving compressors. The use of such compressors renders the gas-turbine installation complicated.

This invention consists in the compression, by the action of a water column to which kinetic energy has been imparted, without the coöperation of the gas turbine. In the form illustrated, a gas turbine *A* is directly coupled to an electric generator *B*. The gas turbine is provided with a combustion chamber *C*, into which are led a fuel supply *D* and an air pipe *G*, leading from a regenerative air heater *F*, the space around the tubes of which is fed from the air-compression space *K* above a water column *L*, the air being drawn into the space by a lead *N*. The passage through the pipes of the air heater is connected at one end *H* to the gas turbine, and at the other to an exhaust. At the end of the water column, remote from the air-compression space, is provided a separate explosion chamber *M*.

In operation, explosions are caused to take place in the chamber *M* whereby



Gas Turbine

energy is imparted to the water column, as in a Humphrey pump, and air is in turn drawn in at *N*, compressed in the space *K*, forced over the pipes of the heater *F* and through the passage *G* to the combustion chamber *C*, where, with the fuel supplied by the pipe *D*, the mixture is formed for driving the turbine. The exhaust gases leave at the port *H*, and flow in a counter-current through the heater *F*, imparting heat to the air supply.

CORRESPONDENCE

A Substitute Piston Ring

Some time ago a trouble man was called in to repair a small air compressor used in supplying air for starting a 50-hp. gas engine. He found the pump badly worn, and was advised by the operators that it took nearly 4 hr. to pump two small receivers to a pressure of 200 lb., whereas it originally took only ½ hr.

Upon starting the compressor, which was a single-acting, single-cylinder, belt-driven machine, with a 3½-in. cylinder and 4-in. stroke, considerable leakage was noticed past the piston. Removing the piston showed that a section about 2 in. long was missing from one of the two rings, which evidently was causing the leak. No extra ring being on hand, it was decided to try an experiment, to tide over until a new ring could be ordered. The ring groove in the piston was ¼ in. wide and about the same depth. A strip from a piece of ⅜-in. hard canvas rod packing was pressed tightly into the groove; then shaved down, leaving about ⅛ in. above the periphery of the piston. It was then taken out and reversed to have the even side out. After putting the piston back, the pump was started and worked as well and pumped up to the pressure as quickly as when new. This ring of hard packing kept the pump in good working order for over two weeks until a new cast-iron ring arrived.

L. M. Johnson.

Glenfield, Penn.

Heating and Ventilation

Considered as power-plant problems. Layout and operation of systems and apparatus

Meter Troubles and Shop Equipment for Testing*

System troubles which prevent correct metering come under three general heads: leaks, traps and seals blowing, and surges of condensation upon the meter. Causes of leaks are poorly packed valves, fittings leaking "90 drops per minute" at threads, and return lines which have rusted badly.

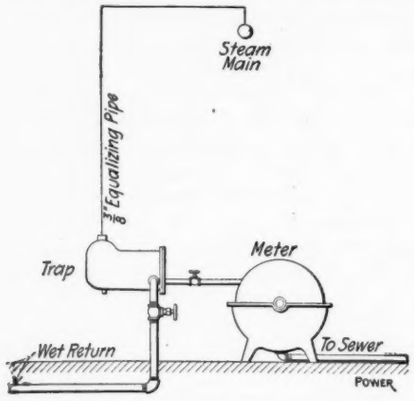


FIG. 1. INSTALLATION WITH WET RETURN

Rusting causes the most noticeable losses. One case coming to view recently, amounting to a tomato can full in 30 min., was found six weeks later to amount to 150 lb. per hour.

Traps and seals blowing, often practically stop meter registration while permitting steam to escape to the sewer. In one case, using metered injection water with the returns permitted checking the

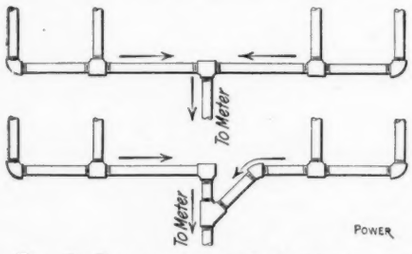


FIG. 2. BULL-HEADED CONNECTION TO METER AND REMEDY

loss of steam with and without one high-pressure bleeder trap; the measurement showed that about 300 lb. of steam had been escaping per hour. Traps sticking or seals choking interfere only by preventing legitimate use of steam. The remedies are, for seal blowing, to replace the seal with a "self-respecting" trap; for traps blowing, to adjust both the regulating valves and the trap; and for traps sticking, to clean and adjust the trap, with better finished valves and more care in installing. When a seal is found leaking, it is generally easy to make repairs or put in a trap at once.

Surging of condensation upon meters is usually caused by wet return jobs, return pipes brought together to the meter "bull headed" and bleeders which, poorly installed, cause "bucking." The most common troubles with suggested remedies are shown in the accompanying illustrations. Where such change is not immediately feasible, one of several devices may be installed to give relief. A receiver, generally submerged, having capacity for most of the surge without a rise in receiver water level of more than about 6 in., may be installed between the trap and the meter. Occupying less space

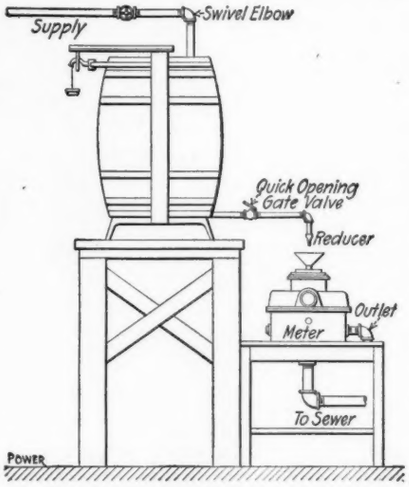


FIG. 3. SIMPLE TESTING OUTFIT

and requiring less investment, a muffler, built up of iron pipe and containing a number of notched rubber disks, so arranged as to form a zigzag path for the condensation through the restricted opening in the disks, is used between the trap and the meter to give a more even flow of condensation during surges, and to permit proper operation of the meter even if the trap is blowing.

Grease accumulation has been found so thick as to entirely stop a number of meters. The grease in these cases has either come from pump cylinder drips or from heating systems into which the pump was exhausted without proper oil separation. In one case, a prolonged kerosene bath changed a meter showing over 4 per cent.

SHOP TEST EQUIPMENT

The simplest equipment, Fig. 3, consists of a platform scale, a barrel fitted with a discharge-pipe connection, a water

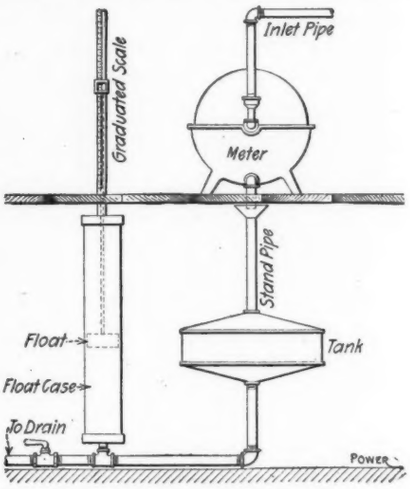


FIG. 4. TANK EQUIPMENT WITH GRADUATED SCALE TO INDICATE WEIGHT OF WATER

supply and a sewer-connection pipe, the meter to be placed upon the floor or a bench. Variations from this, due to the amount of testing to be done and the volume of water to be handled, consist of increasing the scale size to possibly 1500 lb. capacity with corresponding tank capacity in place of the barrel.

The inlet pipe should have a valve and swivel elbow, with a sewer connection handy by which any drip from the pipe or leakage through the valve may be diverted from the tank after the initial weight measurement is made. The discharge pipe should also have a valve and at the outlet a reducer or plug having a definite opening so that all tests of one size of meter may be made under conditions of uniform rate of flow. Quick-opening gate valves have been found advantageous for this work.

In addition to the equipment noted, a large bulb mercury thermometer with a range to 230 deg. inclosed in a wooden case open on two sides, is necessary where any work in hot water, steam or condensation is done. Standard weights for scale testing should also be provided.

Fig. 4 illustrates one form of tank equipment designed to avoid the use of scales. The apparatus consists of two cylinders of No. 14-gage galvanized iron, one of which, 6 in. in diameter, holds a galvanized-iron float for indicating the

*Excerpts from the report of the meter committee to the National District Heating Association at Detroit, A. P. Biggs, chairman.

water level; the other is a combination of a 1½-in. cylinder enlarging for some 8 in. of its length into a cylinder of 24 in. diameter. The enlargement is to contain the bulk of the water used in the test. The float rises rapidly until the water reaches the enlargement, and again rapidly and at uniform speed after the water level passes the top of this drum. A slider attached to the float, passes over a graduated scale and indicates the weight of water in the apparatus. The relative sizes of cylinders may be varied to give different scale divisions. The equipment described provides scale divisions of about 1 in. to 1 lb. of water.

Oak-Park's Hot-Water Heating System*

By G. E. Chapman

The plant of the Public Service Co. of Northern Illinois is in the village of Oak Park, in a one-story structure with a basement. The building is of red brick and reinforced concrete and has a floor space of approximately 22,000 sq.ft. The stack is reinforced concrete lined with firebrick, approximately 200 ft. high from the sidewalk level.

East of the plant is storage room for 10,000 tons of coal, which is received on an elevated switch from the Chicago & Northwestern R.R. tracks. The coal is dumped from the cars directly below the track, as long as there is room for it, and after that the cars are unloaded by a large Gantry crane, which is also used for conveying the daily supply to the bunkers.

In the boiler plant are 14 Stirling boilers, 10 of which have a rated capacity of 300 hp., and four of 450 hp. each; all have automatic stokers. Ashes are

*Abstract of a paper read before the National District Heating Association at Detroit.

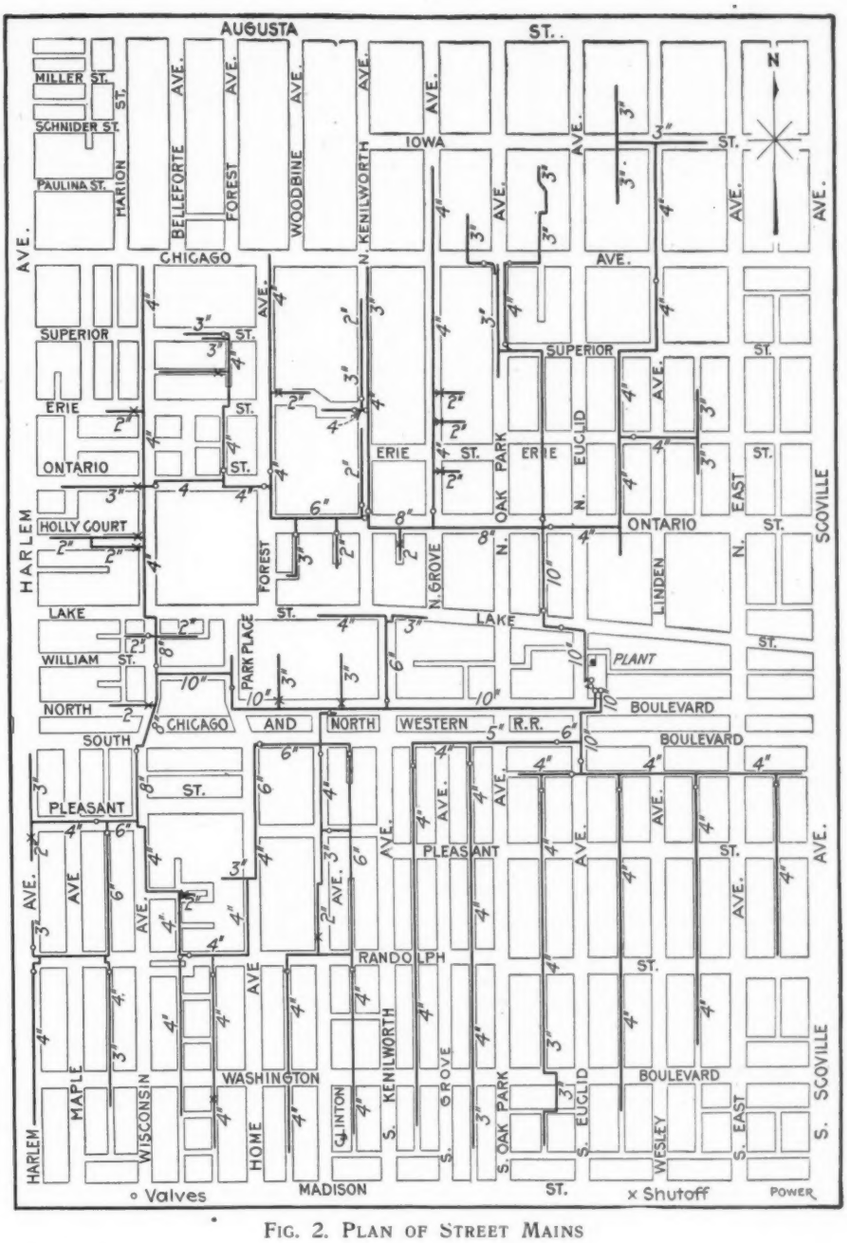


Fig. 2. Plan of Street Mains

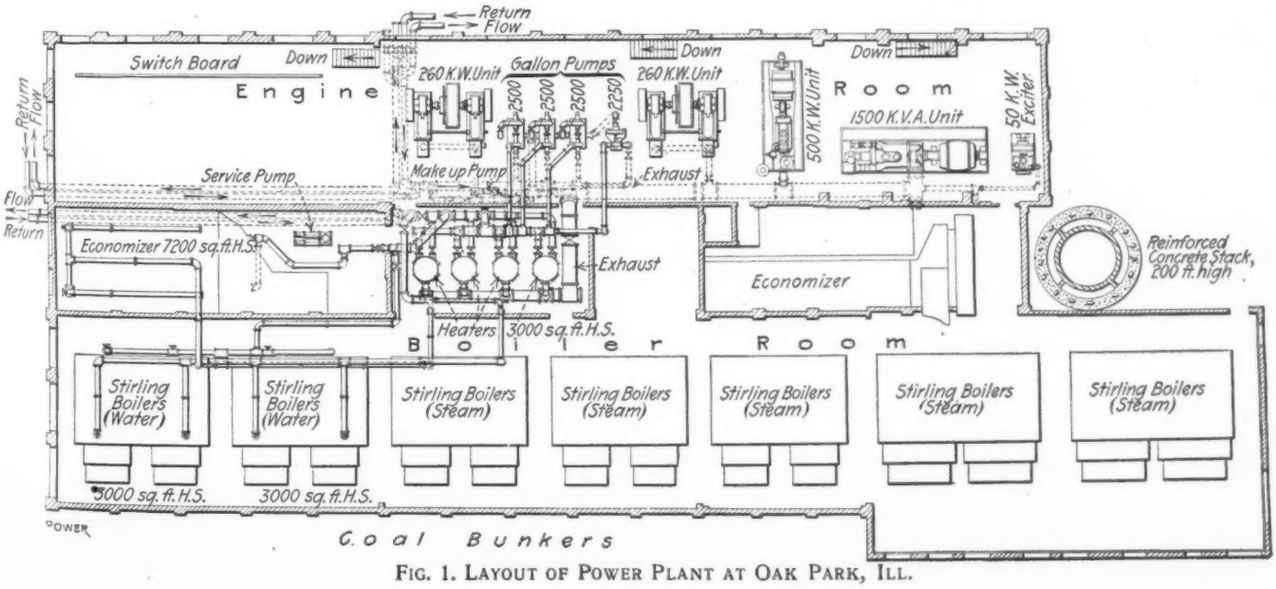


Fig. 1. Layout of Power Plant at Oak Park, Ill.

removed from the furnaces by a steel pneumatic suction system.

The four boilers at the south end of the plant are used exclusively for the heating system, and the remaining ten for generating high-pressure steam for the pumps and electrical machinery.

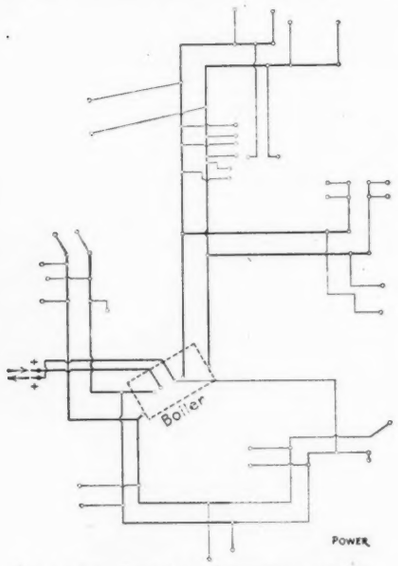


FIG. 3 A TYPICAL SERVICE LAYOUT

A Green economizer, having 7200 sq.ft. of heating surface, operates in connection with the battery of heating boilers, each of which has 3000 sq.ft. of heating surface.

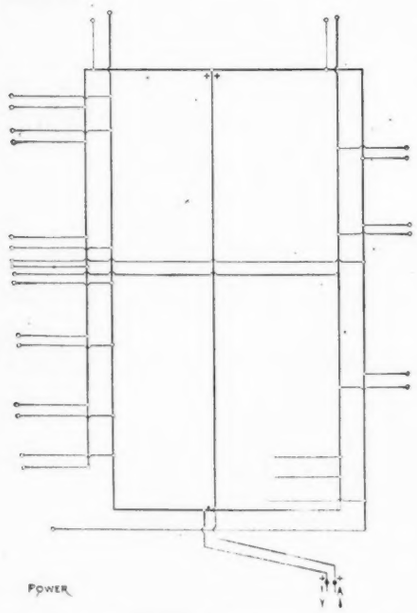


FIG. 4. STANDARD CONNECTIONS FOR HOUSE SERVICE

In Fig. 1 may be seen the four centrifugal steam turbine-driven circulating pumps for the hot-water heating system. One handles 2250 gal. and the other three each 2500 gal. per min. All are directly connected to the closed underground heating system. In connection with this pumping system is a duplex balanced-column make-up pump, automatically governed by the water pressure in the main return pipe. This pump makes up for any water which may be lost through leaks.

The underground system, Fig. 2, is laid out in accordance with the standard Yaryan methods, being a complete two-pipe system. The piping is protected by boxing built on all sides, with a double air space. The lumber is rough-sawed hemlock, preserved by dipping in crude oil. In addition, oiled shavings are tamped in the boxing around the pipes.

There are now approximately 12 miles of two-pipe heating mains, located as shown on the map. Connected to these mains are 710 houses with an aggregate of 550,000 sq.ft. of radiation.

The generating plant includes two Westinghouse turbo-generators, one of 1500 kv.-a., the other 500, both generating 2200-volt, three-phase, 60-cycle current, and two Ball & Wood reciprocating engines, each connected to a 250-kw. Western Electric direct-current generator. The exhaust from all steam-driven machinery is discharged into four Worthington heaters, which can be run in multiple, series or singly, as required. These heaters have a combined heating surface of 12,000 sq.ft. and are sufficient to take care of the entire heating system during mild weather; the heating boilers and economizer are used only in more severe weather.

The accompanying tables give the schedules, which were followed with good results during the heating season. Figs. 3 and 4 show typical piping arrangements for house service. One of these gives poor results, due to complications and short-circuits, but Fig. 4 practically follows our standard practice.

TABLE I. HOT WATER SCHEDULES

Schedules 1					2		3		4	
	Perceptible Wind 0 to 2 Miles				Gentle Breeze 3 to 10 Miles		Brisk Wind 10 to 20 Miles		Very High 25 to 50	
	Temp. Deg. F.				Temp. Deg. F.		Temp. Deg. F.		Temp. Deg. F.	
Gage Press. lb. per sq.in.	Flow	Ret.	Outside Temp. deg. F.	Gage Press. lb. per sq.in.	Flow	Ret.	Flow	Ret.	Flow	Ret.
32	120	100	65	32	135	118	145	112	155	127
32	125	110	60	35	140	120	150	125	160	130
33	135	118	55	35	145	122	155	127	165	132
33	145	122	50	35	150	125	160	130	170	135
33	150	125	45	35	155	127	165	132	175	137
35	155	127	40	40	160	130	170	135	180	140
35	160	130	35	40	165	132	175	137	185	142
35	165	132	30	40	170	135	180	140	190	145
35	170	135	25	40	175	137	185	142	195	147
40	175	137	20	45	180	140	190	145	200	150
40	180	140	15	45	185	142	195	147	205	152
40	185	142	10	45	190	145	200	150	210	155
45	190	145	5	47	195	147	205	152	212	156
45	195	147	0	47	200	150	210	155	215	156
45	200	150	5	47	205	152	212	156	217	157
45	205	152	10	47	210	155	215	156	220	158
45	207	153	15	47	212	156	217	157		
47	210	155	20	48	215	156	220	158		

TABLE 2. U. S. WEATHER BUREAU'S ANEMOMETER REPORT COMPARED WITH STATION'S DAILY AVERAGE

1910	Weather Bureau Report			Station Report				
	Daily Average			Indicated on gages			Operation	
Nov.	Vel. Miles	Direction	Schedule required	Direction	Schedule required	Vel. Miles	Schedule operated	Vel. Miles
1	16	S.	3	S.	2	5 to 10	2½	10 to 20
2	14	W.	3	W.	2	5 to 10	2	5 to 10
3	9	N.W.	2	N.W.	2	5 to 10	2	5 to 10
4	7	S.	2					
5	9	W.	2					
6	7	W.	2					
7	9	W.	2	W.	2	5 to 10	3	10 to 20
8	6	S.	2	S.	2	5 to 10	2	5 to 10
9	16	S.W.	3	S.W.	2	5 to 10	3	10 to 20
10	18	N.W.	3	W.	3	10 to 20	3	10 to 20
11	19	N.W.	3	N.W.	3	10 to 20	3	10 to 20
12	15	N.W.	3	N.W.	2	5 to 10	2	5 to 10
13	6	W.	2	N.W.	1	0 to 4	1½	5 to 10
14	13	N.W.	3	N.W.	2	5 to 10	2	5 to 10
15	13	N.W.	3	N.W.	2	5 to 10	2	5 to 10
16	11	W.	3	N.W.	2	5 to 10	2	5 to 10
17	12	S.W.	3	W.	2	5 to 10	2	5 to 10
18	10	N.W.	3	N.W.	2	5 to 10	2	5 to 10
19	8	S.	2	S.	1	0 to 4	2	5 to 10
20	13	S.	3	S.	2	5 to 10	2	5 to 10
21	16	W.	3	W.	2	5 to 10	2	5 to 10
22	11	S.	3	S.W.	2	5 to 10	2	5 to 10
23	19	S.W.	3	W.	3	10 to 20	3	10 to 20
24	15	S.	3	S.E.	2	5 to 10	2	5 to 10
25	12	W.	3	N.W.	2	5 to 10	2	5 to 10
26	16	E.	3	S.E.	2	5 to 10	2	5 to 10
27	14	S.E.	3	S.E.	3	10 to 20	3	10 to 20
28	18	N.W.	3	N.W.	3	10 to 20	3	10 to 20
29	16	N.W.	3	N.W.	2	5 to 10	2½	10 to 20
30	25	N.W.	3	N.W.	3	10 to 20	3	10 to 20

Issued Weekly by the
Hill Publishing Company
JOHN A. HILL, Pres. ROB'T MCKEAN, Sec'y.
505 Pearl Street, New York.

Monadnock Bldg., Chicago.
6 Bouverie Street, London, E. C.
Unter den Linden 71—Berlin, N. W. 7.

FRED R. LOW, Editor.

Correspondence suitable for the columns of POWER solicited and paid for. Name and address of correspondents must be given—not necessarily for publication

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $5 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 21 Shillings.

Entered as second class matter, December 20, 1910, at the post office at New York, New York, under the Act of March 3, 1879.

Cable address, "POWPUB," N. Y.
Business Telegraph Code.

CIRCULATION STATEMENT

Of this issue, 33,000 copies are issued.

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

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POWER

Rights of the Consumer

That it is not always advisable to accept a very low rate from an electric company is strikingly illustrated by a recent decision of the Appellate Division of the New York State Supreme Court in the case of the Globe Woolen Co. versus the Utica Gas & Electric Co.

The Globe Woolen Co. made a contract with the electric company for five years at a rate of 1.04 cents per kilowatt-hour with the privilege of renewing the contract for five more years. Furthermore, the electric company guaranteed to save the woolen company $600 a month in the operation of its plants as against the previous operation by steam power. In case of shortage of power the woolen company and the city of Utica were to be served ahead of all other customers.

This contract was negotiated by the president of the woolen company, who was also chairman of the executive committee of the electric company and owned a large part of the stock of the woolen company, but had no financial interest in the electric company. It is claimed that, although attending all the meetings of the executive committee of the electric company at which this contract was discussed, he did not vote on its acceptance.

After a few years the electric company found that it had delivered to the woolen company current to the value of over sixty-nine thousand dollars for which it had received no compensation under the contract, and in addition owed the woolen company nearly twelve thousand dollars on account of the promised savings. It thereupon offered to remove from the woolen company's mills, without cost, all the central-station service equipment, to reimburse the latter for its cost and to reinstall the necessary boilers and other steam equipment to permit the operation of the mills by steam as formerly.

The woolen company allowed the electric company to reinstall the steam equipment at an expense of eighteen thousand dollars, stipulating, however, that this was to be without prejudice to any rights under the contract.

Shortly after the woolen company elected to renew the contract for a second period of five years but the electric company refused and served notice that the power would be cut off on a certain date. The woolen company immediately brought suit in equity for an injunction, and a temporary injunction was granted pending the trial.

The outcome of the trial was that the Appellate Division of the Supreme Court held the contract not to be enforcible against the electric company and said in part:

"It would seem to be unnecessary to multiply the citation of authorities in support of the proposition that where contracts are made or entered into between two corporations under the circumstances disclosed, and the result thereof is that the contracts are greatly to the advantage of the plaintiff and to its president individually, who negotiated the same, and are grossly inequitable and burdensome to the other party, such contract may be repudiated at the option of the party aggrieved, and if such repudiation is accompanied by an offer of the aggrieved party to place the other party in the same position in which it was before making such contracts, they thereby cease to be valid and binding and are not enforceable either in an action at law or in equity."

Presumably the electric company had carefully investigated the operating conditions at the woolen mill before offering the exceptionally low rate, but it is apparent that it had neglected to take into consideration the value of the exhaust steam for heating and for manufacturing purposes.

While the case at hand savors of the personal influence of the woolen company's president, still it is by no means an isolated case, as contracts of this nature are continually being entered into. The customer is naturally desirous of obtaining as low a rate as possible while the central stations in their eagerness to get the business (sometimes to effect a

monopoly, and other times to serve publicity) often make propositions which they are unable to meet without loss.

The rights of the consumer under such a contract is of vital importance and the recent court decision would not seem to strengthen these rights. Hence it behooves the consumer to think twice before entering into a contract for electric power at what appears an attractive rate.

New York Boiler Inspectors again Discredited

Quietly, obscurely, in inconspicuous corners of the daily papers overshadowed by the reports of graver charges against his department, comes an announcement by Police Commissioner Waldo, of New York, that policemen Owen Kelly and John Heffernan, of the boiler squad, have been suspended, charged with accepting money in connection with their duties.

Is not the time propitious for getting the examination and licensing of engineers and the inspection of boilers into a better atmosphere? The past attitude of some of the New York City engineers would indicate that they rather enjoyed putting up from twenty to fifty dollars every time they went or sent to headquarters, or that they hoped to avoid by friendly service the personal "touch." An intelligent united effort for a state license law, uniform with those of Massachusetts and Ohio, would find some of the most formidable opponents of past efforts for such legislation very busy trying to keep themselves out of jail.

Kansas City

On Sept. 10 the thirtieth annual convention of the National Association of Stationary Engineers will be held in Kansas City, Mo. Those who attend are to be congratulated if on no other score than that they will visit this great and going metropolis of the Missouri and her mighty little sister lying just across the state line and the Kansas River.

Although combined these two cities would be only seventeenth in population in the United States, they are seventh in postal receipts, sixth in bank clearings, third in telegraphic business, horse and mule trade, flour output and lumber, second in meat-packing, railroads and in grain receipts and first in yellow-pine lumber, sale of agricultural implements and Pullman business. What is perhaps most significant of the future, however, is that they are first in tributary territory and first in the richness and extent of contiguous farming territory. At any rate, the 18 railroad systems, representing 34 lines that enter Kansas City, Mo., seem convinced that a splendid future is in store for these municipalities, for they are now spending $35,000,000 for improved terminal facilities alone. The new union station, now being erected and which alone will cost $4,500,000, it is said will be the most modern in the world.

As may be inferred from the foregoing, the Kansas Cities are good business and manufacturing communities. The Mercantile Club of Kansas City, Kan., lists over 175 manufacturing plants in that city and representing over 60 different lines of business. Kansas City, Mo., contains a proportionately greater number. John F. Linden, boiler inspector for the latter city, is authority for the statement that there are 190 power plants in Kansas City, Mo., containing an aggregate of 837 boilers and 160 plants containing a total of 220 high-pressure boilers and giving employment to 518 first-class licensed engineers.

Criminal Negligence

The need of a state license law in Kansas was emphasized by the recent explosion of a thirty-inch by six-foot vertical boiler at a rock-crushing plant in Rosedale. The engineer was killed and another severely injured. The boiler, which was connected to another vertical boiler of larger size, was thrown sixty-five feet from its setting.

A boiler maker, appointed by the coroner to determine the cause, found no safety valve or steam gage. The packing-gland nuts on the water column showed that there had been no glass and only one of the gage cocks was in working order; the other two were found plugged. Corresponding with the general state of dilapidation, the blowoff valve had no wheel. The back plate of the firebox and the tube sheets of the damaged boiler had been bulged in and twenty-seven out of the fifty-five tubes were out of place, the ends giving evidence of considerable deterioration. The boiler was reported to be a castoff from Kansas City, where a license and boiler-inspection ordinance is in force.

It is the same old story, with a little more of it. We have reported similar explosions, but have never heard of a case where the operating conditions were quite so adverse to safety. The practice of buying old and discarded boilers is too dangerous. What does the small saving in initial investment amount to when compared with the loss of life and destruction which is almost sure to follow?

Evidently legislation providing competent inspection and regulation is badly needed, and this applies to many other states in the Union besides Kansas.

'Twas ever thus. John Bourne in the preface to the first edition of his "Treatise on the Steam Engine," published in 1846, says: "I have been obliged to confide the greater part of the theoretical part of the present work to some mathematical assistant whose algebra has, I fear, sometimes risen to a needless luxuriance, and in whose superfine speculation the engineer may perhaps discern the hand of a tyro."

An act providing for the inspection of steam boilers has been passed by the Legislature of New Zealand and goes into effect on Sept. 1 of this year. Of these United States only two have such laws in universal application and we count up a boiler explosion of sufficient importance to get into the papers at the rate of more than one every working day.

The operating engineer who attempts to perform work foreign to his vocation or outside his capacity—and his tribe is decreasing—calls to mind the chameleon who tried to make good on a Scotch plaid, and proved a dead failure.

A contemporary has recently been the medium for exchanging the views of the head of an engineering supervision company and a chief engineer which it displaced. According to the latter, he had been trying for years to get the management to adopt certain improvements but without success. When the supervision company stepped in, however, it easily convinced the management as to the needed improvements. It would seem that if the operating engineer had presented his case as clearly and convincingly (as the supervision company evidently did) there would have been no intrusion of outside interests.

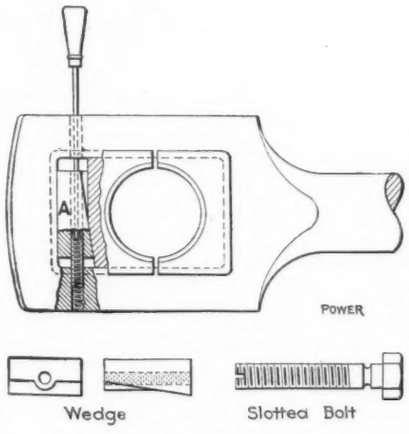
Readers with Something to Say

A letter good enough to print will be paid for. Ideas, not mere words, wanted

Slotted Connecting-Rod Wedge Bolts

The solid-end rods used by some manufacturers of large engines have the wedges placed in the slot of the rod with the brasses before the rod is put on the crankpin or connected in the crosshead. This makes a very desirable form of adjustment to take up the wear of the brasses, but with some forms of these wedges it is difficult to remove the brasses or wedges to put shims under the brasses to true them up and raise the wedge. With such types of rod ends removing a broken wedge bolt is also very difficult. This could be avoided if the wedge bolts were slotted in the end to allow using a screw driver, as shown, for removing them. The following circumstance well illustrates this:

The bolt broke on the crankpin end of the rod just as I was keying up at noon.



REMOVING BROKEN WEDGE-BOLTS WITH SCREWDRIVER

Thinking this wedge was only slipped in back of the brass and flange, which I knew was bolted to the ends of the brasses, I proceeded to remove the washer from the end of the pin only to find a wedge I could not remove without taking out the wristpin and pulling the crosshead back. This allowed removing the wedge and brasses from the pin by moving the connecting-rod outward at the same time.

The wedge *A* in the illustration was very thin at the top, and the bolts were ¾ in. To get strength enough at this point of the wedge to stand the drawing strain of the bolt, the wedge was cast with a ½-in. projection on the incline along the bolthole, and this projection fitted into a slot in the back of the brass next to the wedge. The wedge could not be removed without removing the brasses. The brasses could not be removed on account of the flanges on the side of them. To do this the connecting-rod would have to be taken out first.

This would require about two hours, and as it was the bottom bolt that broke, I left the job until evening, the top bolt keeping the wedge up tight. After much trouble I succeeded in slotting the end of the bolt after which a screwdriver was used as shown to back it out. The end of the new bolt was slotted before being put in.

The builders should slot the ends of the wedge bolts as it saves much time and trouble in taking them out when they break off in the rod.

R. A. CULTRA.

Cambridge, Mass.

Rosin for Bending Boiler Tubes

Using sand for bending pipe and tubes is not always successful, as kinks are likely to form despite care in bending. To obviate this trouble a friend recommended rosin to fill the tubes instead of sand, so the tubes were filled with melted rosin which was allowed to get quite cool. Then they were taken to a flange press where, one at a time, they were bent over a former to a neat quarter circle with 20-in. radius, and scarcely a kink was noticeable. In most instances, perfect results were obtained.

The use of rosin is quite inexpensive, as it can be melted out of the tubes after bending and can be used over and over again. I have never seen rosin tried in bending pipes, but see no reason why it would not do as well for pipes as for boiler tubes. I presume there is scarcely an engineer who has not been disgusted at various times with his efforts to make a neat pipe bend.

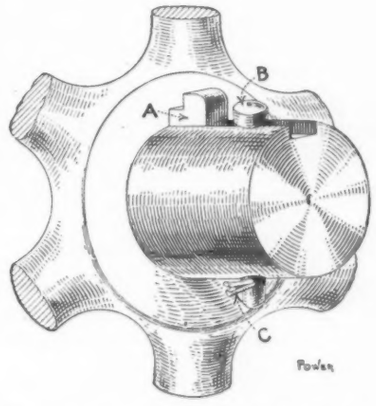
C. R. SUMMERS.

Chattanooga, Tenn.

Safety Pin for Flywheel Keys

The sketch shows a device used by a firm making portable engines to safeguard against accident. They are largely operated by unskilled labor for agricultural work. Under these conditions it is possible that if the key slacks back it would pass out unnoticed and lead to serious accident. With the provision illustrated, the key cannot work out of the slot and is bound to be noticed and tightened before harm is done.

Each engine has two flywheels, each secured by a draw key *A*, as shown. After the key is driven home, a hole is drilled in the keyway of and through the shaft, and a short taper pin *B* is fitted in, having a split pin *C* at its smaller end to prevent it from coming out.



SAFETY PIN TO PREVENT ACCIDENTAL REMOVAL OF FLYWHEEL

The cost of the device is trivial and the security against accident is undoubted.

A. L. HAAS.

London, England.

Writing for the Papers

Not many years ago, writing was supposed to be an accomplishment possessed by the professional engineer, but seldom indulged in by the so-called practical engineer. The latter thought he could not write a satisfactory letter, so simply let it go without trying. Much information of value was thus lost that would have been valuable to others. Now POWER makes it plain that it wants to hear from anybody who has anything to say that will benefit others of the craft. This is an age of giving away, particularly so in the realm of education. As Elbert Hubbard says, "The more education we give away to others, the more will we have left for ourselves."

Lots of engineers have lots of information to give away, or at least to exchange for some they need. They have the chance to give and to get; to cultivate any latent talents they may have; to

broaden out mentally—but not in the sense of getting a swelled head..

Get out of self, and get into the arena where the battle of progress is going on. Be on the side of those who are helping it along. Don't be a hinderer—though passive. Don't be like the person in the following verse:

"As I walked by myself, I talked with myself;
Says myself to me,
Lookout for yourself, take care of yourself,
For nobody else cares for thee!"

That is the attitude assumed by many, but is a dangerous rut to get into. Service to others, helping them to help themselves that they in turn may help others, is the truly satisfactory life to live, and one very good way to help others is to write and tell them what you know and what you do, and it will come back to you multiplied.

Byron wrote:

"But words are things, and a small drop of ink,
Falling, like dew, upon a thought, produces
That which makes thousands, perhaps millions,
Think."

CHARLES J. MASON.

Scranton, Penn.

Pressure Chart Reveals Negligence

The accompanying charts from a recording-pressure gage graphically illustrate the importance of records in a plant.

A large flywheel steam pump delivered water through a 10-in. main from which large quantities were being continually taken at different points. The men in charge of the pumping outfit being negligent, insisted that they could not control the pressure to show a chart any better than Fig. 1, and even this chart is much better than some recorded while the pump was under their charge. A new chief engineer was appointed who undertook to run things for a straight 24 hr. to determine the cause of the fluctuating pressure. He obtained chart, Fig. 2, with only reasonable attention to his work. The men were then notified that they could either attend to their duties properly or resign. They decided to retain their jobs. They were on their regular shifts with the chief when he ran his test, and had no excuses to offer, as they were shown plainly that all that was necessary to obtain a fair record was honest attention to their duties. Their pressure diagrams are now as good as and often better than those obtained by the chief.

JOHN THORN.

London Junction, Ont., Can.

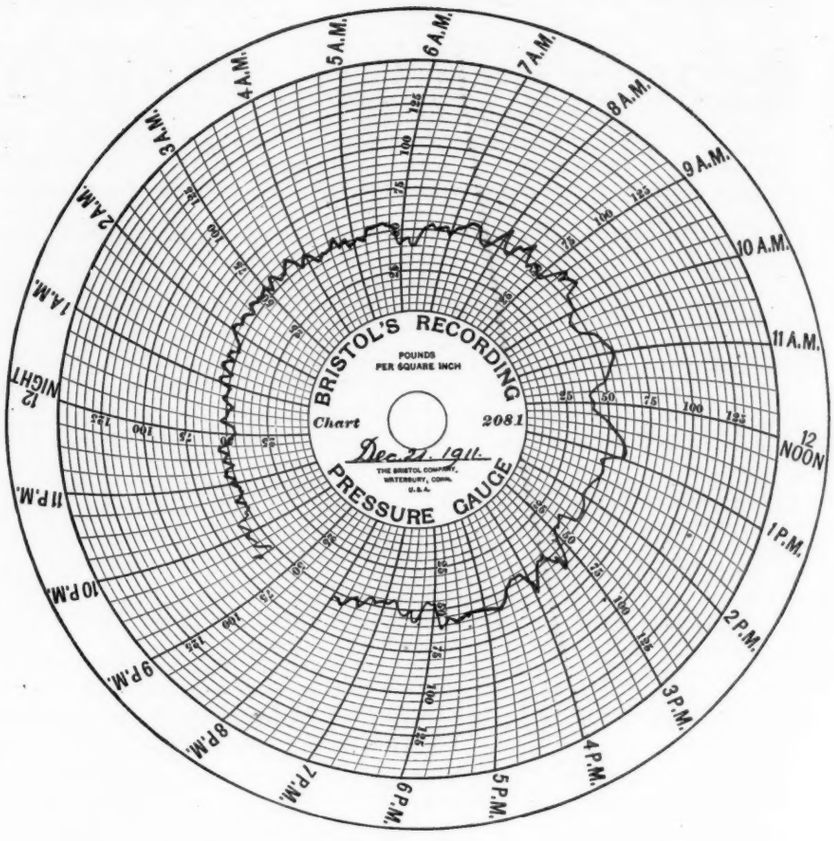


FIG. 1
PRESSURE MAINTAINED UNDER NEGLECTFUL OPERATION

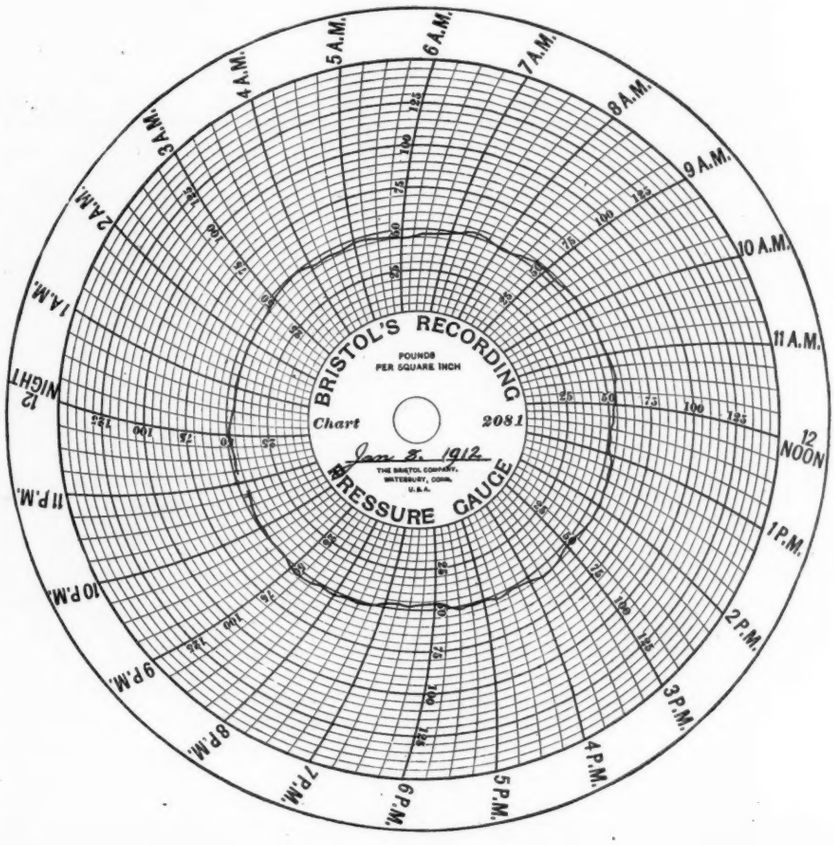


FIG. 2
PRESSURE MAINTAINED UNDER CAREFUL OPERATION

Baffle Plates in Water Tube Boilers

Strange as it may seem, there appears to be a tendency to neglect to an alarming extent the baffle-plates in a water-tube boiler. In some cases, ignorance, and in others sheer laziness is the cause. I have heard it said positively that the plates were no good, were only dirt catchers, and in one case they even went so far as to take them out of the boiler entirely "to give her a free draft," as they explained later. Needless to say they were replaced. When an engineer has had opportunity to see the detrimental effects of broken and leaky baffle-plates upon the efficiency of the boiler, and upon the coal pile, he will never neglect them again.

Men are prone to neglect the nasty, hot jobs around a boiler plant, especially where they are not easily seen. To the average boiler cleaner, no doubt it seems a small matter if a few of the bricks in a baffle-plate are gone, and a few holes burned in the plate. He probably figures that the chief will never bother to climb into the boiler and examine them, and often he is right, as some engineers are satisfied to take the word of their subordinates rather than get into overalls and get dirty in a personal examination. The chief of a large plant cannot attend to every little detail, but he should always have time to examine his boilers.

Replacing the bricks is a hard, nasty job. To do it quickly, takes three men, two with bars to pry the tubes apart and one to insert the brick. Often the corners are knocked off the brick so that it will slip in place. This is bad as the space is not completely filled, and a firebrick once broken apparently continues to break until it falls out again. A tool now on the market will do the job very neatly and without breakage, so not keeping the baffle-plates in good condition is inexcusable.

WILLIAM N. WING.

Brooklyn, N. Y.

The Use of Fuel Oil

That fuel oil is not more used under boilers is not from lack of good oil burners. Even where fuel oil is cheap, the deterioration of boilers from burnt out tubes for the first year or two will more than offset the saving in fuel, and some users will go back to coal. Experts will appear, offering a special plan of bricking up the combustion chamber, each claiming that the boilers will then last as long as when burning coal. Generally they do but little good, for the work along this line seems to be in the wrong direction.

In coal firing the object is to generate a certain amount of heat, confine it as much as possible to the heating surface of the boiler, and have it evenly distributed, without any cold streaks along any part of the heating surface. As Kent's "Steam Boiler Economy" says, the largeness of the firebox does not detract from its efficiency, as the heat generated cannot escape except by going through the regular paths and giving up its proper portion of heat to the surface, once the walls have been heated up.

When such a boiler is to be converted for oil burning, a hole is drilled between the two firedoors, a burner inserted, all connections made and the blast turned on. A hot fire is the result, for the same amount of heat must be produced by this one flame as by a bed of incandescent coal evenly distributed over the whole grate area. Therefore the flame temperature must be considerably higher than with the coal fire to produce the same amount of heat. The blast of an oil burner draws in a stream of cold air on either side of it, which follows along either side of the current of hot gases throughout the heat passages to the stack. So a part of the boiler evaporates more water and faster because of the higher temperature than was intended by the designers, while other parts possibly receive more heat from the water circulating in them than from the firebox.

With converted boilers in a new field, the above conditions hold in nine cases out of ten. Some makers send out boilers arranged for burning crude oil; one such boiler that I happened to see had three burners for only 1200 sq.ft. of heating surface.

Personally, the writer favors using a burner every 6 in. across the front of the firebox, and obtaining the required amount of heat without excessive temperature in any one place.

Smaller burners and more of them would seem to be the proper idea.

SAM FOSTER.

Tampico, Mexico.

Systematic Note Keeping

Those who write for the technical press often think of ideas or incidents, that would interest readers, but, failing to note them down, forget them, and thus much that would be of value to engineering literature is lost.

To keep track of all such ideas and experiences I have procured a desk calendar pad, with a separate sheet for each day and date and thereon record everything worthy of notice. At the end of the week I transfer these notes to an indexed ledger, somewhat on the order of the indexes issued by POWER. I can refer to it at any time with the knowledge that the incident will be vividly recalled by the information conveyed in the heading.

The dates are kept up as mercantile accounts, and when I have written and mailed an article on a subject, I indicate it by the mark "x," and when the article has been published, I check it off, designating in figures, as "6-15-12," the month, day and year published.

From my experience I believe a greater number of engineers would write occasionally, and many could write more and better letters if they would but keep things of this sort collected more properly, since, by the haphazard methods usually employed, they lose interest and put off writing upon a timely topic until the subject begins to wane in the columns of their paper.

If anyone can suggest an improvement, or a better way altogether than mine, I would be pleased to see it published.

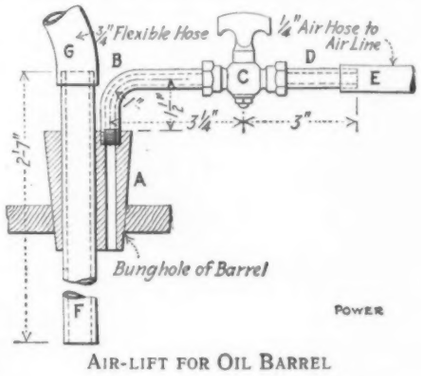
LLOYD V. BEETS.

Nashville, Tenn.

Emptying Oil Barrels by Compressed Air

The means a company employed to transfer oil from barrels to storage tanks was very cumbersome. The tanks were on the first floor, and a barrel to be emptied had to be hoisted above the tank inlet. I designed the device illustrated, which will empty a barrel in a few minutes without much labor.

A cast-iron plug *A* is made to fit the bung hole of the barrel, a ¼-in. air pipe *B* is tapped into the top of the plug, as shown, and a ¼-in. air valve *C* is screwed on this air pipe. A short nipple *D* and a ¼-in. air hose *E* are secured on the end of the nipple and connected to the main air line. The hose should be long enough for the device to be moved from



AIR-LIFT FOR OIL BARREL

tank to tank. A ¾-in. standpipe *E* should slide snugly through the cast-iron plug so no oil can escape. On the end of the ¾-in. pipe is a ¾-in. flexible hose *G* long enough to reach the inlet of the tank. The operation is as follows:

Roll the barrel near the tank, take out the barrel plug and insert the cast-iron plug by giving a few taps with a hammer so as to make a tight fit, force the ¾-in. pipe to the bottom of the barrel, connect the flexible hose to the tank, turn on the air, and in a few minutes the barrel will be empty.

W. H. WOLFGANG.

Toledo, Ohio.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Smoke Prevention with Automatic Steam Jet

In the Jan. 16 issue there appeared reports of two boiler trials conducted by the writer, showing how a fuel saving of 10 per cent. was effected together with increased plant capacity by the installation of smoke-preventing apparatus.

A criticism by Henry Misostow appeared in the Feb. 20 issue in which the critic makes a rule-of-thumb statement to the effect that the difference in draft in each set of tests is wholly inadequate to account for the saving of fuel seemingly realized; and yet it is sufficiently great to prove to his satisfaction that the increase in economy was due to a difference in the manner of handling the fires. In conclusion Mr. Misostow says: "So far as an economy of 10 per cent. of fuel goes, the steam-jet man must be given credit for doing the right thing at the right place in these two cases, obtaining the same result by different changes in the two furnaces, and the credit for the whole change is given to the steam jets."

Before replying specifically to the criticisms, I might say that at each plant the draft was practically unchanged for the two tests; furthermore, the handling of the furnaces was almost identical for both tests. The "steam-jet man" had nothing to do with the tests, not even being present as a spectator. Moreover, credit for the fuel saving is given by the writer not to the steam jets but to the automatic steam-jet apparatus—a distinction which I hope to make clear.

The crux of the entire criticism lies in these words of the critic: "The rate of combustion depends on the draft." This is a very orthodox statement; if coal were pure carbon it would be strictly true, and with anthracite coal the rate of combustion does depend almost entirely upon the draft. But the statement emphatically does not apply to soft coal; and especially where hand-fired.

To corroborate my statement, I shall follow very closely the matter presented in a recent bulletin of the United States Bureau of Mines, upon "Steaming Tests of Coals and Related Investigations." When a fresh charge of bituminous coal is spread over the hot coke on the grate a considerable part is rapidly distilled off. This distillate consists of gases and liquids—by liquids being meant the heavy hydrocarbons which are carried upward in a pasty condition and which probably exist as small globules of coal tar. This gaseous and liquid combustible must be burned in the combustion chamber, and the completeness of the process depends upon the length of time it remains within the combustion space, on the temperature, on the supply of oxygen admitted through the firing doors and on the thoroughness with which the oxygen is mixed with the combustible. If the mixture is good the gases burn in possibly a fraction of a second, but the heavy hydrocarbons require a much longer time. Furthermore, to burn them completely requires a violent mixing with the air since the oxygen can act only on the surface of each globule, and each globule contains many times more combustible matter than a like volume of gas. If these globules are carried out of the combustion zone and cooled below the ignition temperature before the process is complete, they appear at the top of the stack as heavy smoke and probably form the greater part of the loss, due to incomplete combustion.

Poor combustion due to small combustion space is usually made worse by inadequate mixing of the gases. It has been shown that the gas leaving the fuel bed is very rich in combustible and deficient in free oxygen. Therefore, it is always necessary to add air to the gases rising from the hot fuel. If the air is admitted through large openings, such as the firing doors, it may pass through the furnace as one solid stream alongside of another large stream of combustible gas, without materially improving the completeness of combustion. To help the combustion, the air must not only be admitted but must be intimately mixed with the combustible gas if the latter is to be completely burned in the short time that it is allowed to stay within the furnace.

From this discussion it should be clear that it is not the rate of combustion which depends on the draft, as Mr. Misostow states, but the rate of driving the combustible out of the fuel—an altogether different matter.

However, my purpose in quoting from the bulletin is not primarily to controvert my critic, but to emphasize two important considerations in connection with smoke prevention. The first is: The appearance of smoke from a chimney is evidence of incomplete and wasteful combustion. The second consideration has to do specifically with the automatic steam-jet apparatus which was the subject of my former article. This apparatus consists, in part, of steam jets which begin automatically to discharge steam into the combustion chamber whenever a fire-door is opened, in part, of special fire-doors carrying large dampers which remain open when the doors are closed, and finally, of a dashpot arrangement whereby the steam is gradually cut off and the dampers are gradually closed after a predetermined period following stoking has elapsed. The apparatus accomplishes precisely the important function referred to in the preceding discussion from the Bureau of Mines bulletin. The open dampers afford the needed avenue for the inspiration of air. The steam jets act as an inspirator and heater of the air, causing the relatively slow influx of a relatively large volume of heated air just when the combustible distillate is rising from the fuel bed, and finally, the steam jets cause such a swirling within the combustion chamber as to insure mixing of the gases.

The economy effected is therefore due partly to the more complete combustion and partly to the resultant cleanness of the boiler tubes which ensues from the almost complete absence of the formation of smoke. To the latter effect may be ascribed the increased steaming capacity.

J. A. SWITZER.

Knoxville, Tenn.

"Principe di Piedmonte" Accident

The account of this accident and the editorial in the July 30 issue recalls a similar accident to the old steamer "Osceola" on the Great Lakes some years ago when a cast-iron ell on the steam pipe to the main engine burst. The chief engineer, whose room was directly above the ell, was fatally scalded.

Cast-iron ells or fittings are not now permitted in marine service, but copper pipes, unless properly inspected and annealed from time to time, become almost as unreliable as cast iron when allowed to become crystallized as must have been the case on the "Principe di Piedmonte." The rolling and working of a ship in a heavy sea sets up a great variety of strains unknown in stationary service and require extreme vigilance on the part of the engineers to prevent accidents.

I have taken down and inspected cop-

per steam and water pipes on steamboats and have very often found cracks reaching nearly around the pipe which sometimes carried steam at 100 lb. or more. A man standing alongside or directly over a pipe so affected while handling the engine is in constant danger of being scalded to death. Marine inspectors should compel all copper piping carrying steam at ordinary pressures to be annealed at regular intervals sufficiently close to prevent crystallization of the pipe.

A. A. BLANCHARD.

Lakeland, Fla.

[The rules of the U. S. Board of Supervising Inspectors of Steam Vessels relative to copper pipe state that flanges on such pipe of over 3 in. shall be of bronze or brass composition and securely brazed to the pipe. All such flanges shall have a boss projecting from the back of the flange a distance sufficient to be properly riveted to the pipe and of ½ in. thickness.

The breakage of such pipe usually occurs along the rivet circle due undoubtedly to crystallization. No mention of annealing is made in the rules.—EDITOR.]

Securing a Loose Piston

While running a small engine the piston became loose on the rod as in the case mentioned by John Creen in the July 2 issue. The rod screwed through the piston and was riveted tight. The riveted end broke off, so I had the rod screwed into the piston as tight as possible, then two holes were drilled and tapped for ½-in. capscrews on the periphery of the rod and the hole in the piston. After making the screws tight, they were cut off flush with the piston. This engine was in operation without any further trouble for three years after the repair, until a larger engine was installed.

ROY STAHL.

Rising Sun, Ohio.

Gate Valve Repair

Several critics, accustomed doubtless to the smaller valves used for steam piping, have scouted the account of a repair of a gate valve by through bolts between the flanges, described in POWER for June 25, page 891, as impossible because "the body is always nearly as large as the flanges." Anybody who is sufficiently interested will find the valve repaired as described, in the Municipal Lighting & Pumping plant at Orange, N. J. This is a big water-works valve on the suction of a pump, as the article states. Furthermore, there are many standard valves made which will permit of rods passing through the flange bolt-holes, past the body of the valve at the sides and bottom.

They are also facetious about the remark that the fracture was caused by shutting the pump down too suddenly. Water comes to the pump under a 49-ft. head, as stated in the article describing the plant, and published in the May 9, 1911, issue of POWER. The pumps take the water from the suction pipe about as fast as it is supplied, and at times a sudden stoppage of the pump has built up a pressure in excess of 90 lb. per sq.in. Water-hammer was the direct cause of the broken valve as attested by the fact that the installation of a relief valve on the suction pipe set to operate at 25 lb. per sq.in. has eliminated the trouble, and no further shocks have been produced on the pipe and valve.—EDITOR.

High Place on Diagram

Probably the high point at the top of the admission line of the diagram submitted by W. J. L. in the June 25 issue is due to a small steam line with a large separator near the throttle. The separator will act as a receiver to force the pencil to indicate a greater steam pressure than can exist throughout admission due to the small steam line. Reducing the lead will no doubt tend to partially remedy the difficulty.

R. G. LOVELL.

Courtland, Ariz.

Speed of Flywheels

The answer to P. S. on calculating the safe speed of flywheels, page 749, May 21 issue, was interesting. With cast iron the low stress per square inch, as given (or the high factor of safety), is used for several reasons, principal among which are, the unreliability of cast iron, its liability to shrinkage strains, and the serious results of failure. While engine speeds and flywheel diameters are ordinarily such as to make a peripheral speed of about a mile a minute perfectly convenient, it sometimes happens that, in machinery other than steam engines, more inertia or flywheel effect is needed than can be obtained in the limited space available. This must then be obtained by velocity. Steel readily suggests itself but, as cast steel costs considerably more than cast iron, the cost may at first seem prohibitive. This objection will disappear when calculations are based upon the higher safe speed permitted by steel and the consequent smaller dead weight required to obtain any given inertia.

When space is not limited, the same idea applies to lighter rims and greater diameters, since, at a given rotative speed, inertia varies as the square of the diameter.

When it is desired either to speed up a given wheel or to reinforce it, or both, a convenient way of using steel of very high tensile strength is to use passenger-car wheel tires, or locomotive-driving tires, depending upon the desired size. They may be purchased without flanges, already bored to the exact diameter desired, at prices close to the price of steel castings and sometimes for less. If the full thickness of a new tire is not required, old tires, which have repeatedly been turned down on account of wear until they are about 1½ in. or 2 in. thick, may be obtained from any railroad at a low figure, and these, when shrunk on, make a good means of reinforcing an old wheel or building up a new one for special purposes. With new tires the tensile strength varies with quality, between 90,000 and 120,000 lb. per sq.in. This is because some classes of service require soft tires and others hard. A somewhat lower figure should be used with tires that have been subjected to vibration for years.

E. G. MEDART.

Quincy, Ill.

Safeguarding Life at Sea

Your editorial comment in the June 11 issue, "After Honors—What?" I consider to the point, and I trust you will continue to urge the need of safeguarding the lives in ship's boiler and engine rooms until your efforts are rewarded and those who go to sea are properly considered and provided for.

There is much room for improvement in properly equipping ships for safety, and, while the horrors of the "Titanic" disaster are fresh in the minds of all, is the proper time to begin to analyze the suggested improvements and select those that are practical and effective.

I think, as you suggested in your editorial, "The Inconsistency of the 'Titanic' Disaster," May 7 issue, that it is reasonable to believe that this ship could have been kept afloat until all on board were rescued, if some way had been provided for quickly connecting the engines to powerful centrifugal pumps. This seems a simple enough matter, as the pumps might be located forward of the engines with disengaging couplings, or if it is desirable to run the pumps faster than the engines, which is very likely, suitable gearing could be provided.

LLOYD V. BEETS.

Nashville, Tenn.

Repairing Boiler Tubes

Mr. Burns' article under this title, in the June 25 issue, was interesting. It is not new to attempt to regain the original form of a bagged tube by heating and driving the metal back to place. Using a roller for this purpose is unusual to me, and the question arises; is it safe?

Many boiler attendants have been scalded to death by the bursting of tubes in water-tube boilers, and many have received painful and serious injuries from

the same cause. No manner of repairing tubes should be adopted that can in any way produce a greater hazard in this class of accident. A small cylinder, of the proportions of a boiler tube as regards its thickness and diameter, may have enormous internal strains set up in it by being heated locally.

I believe that some of the apparently inexplicable tube accidents, which have resulted from the blowing out of a section of the tube, may be possibly accounted for by such repairs as described by Mr. Burns, or by continued overheating and cooling occasioned by the presence of scale. Merely being bagged makes a tube dangerous because the bagging of the metal would be certain evidence of local overheating, but the change in shape caused by the bagging would tend to produce flexibility which would reduce the amount of strain set up in the structure by subsequent cooling.

Why is the driving up of a bagged tube a benefit? If a tube is bagged so little that the condition of the metal would warrant it being set up to its original shape, there can be no special reason for the further lodgment of scale at this point, for the rapid circulation of water tends to prevent a slight depression from being different from any other portion of the tube in this respect. About the only advantage in setting up a bag will be derived from the ability to clean the interior surface of scale with the ordinary cleaning tools, but a few blows with a light hammer should dislodge the scale effectively from this part of the tube. A tube with a bag so pronounced as to be likely to give further trouble by scale lodging in it, should be replaced, and tubes less bagged are probably safest as they are. A tube which has split should certainly not be rolled or driven up, and it is almost incredible that a repair as described by Mr. Burns, would be attempted on a tube in this condition. Such a repair would render the further use of the tube hazardous, and should not be permitted.

J. E. TERMAN.

Hartford, Conn.

Why Cylinder Tops Wear

Referring to William E. Dixon's letter in the general correspondence columns of the June 11 issue, and to C. E. Anderson's letter in the refrigeration department of the June 18 issue, I would state that I have had similar trouble with a heavy mill engine.

The cause of the trouble was not far to seek. The adjustable shoe on the bottom half of the crosshead had become slack, thus letting the crosshead down on the guide with the result that the piston rod, with the crank-end stuffing-box as a fulcrum, raised the piston causing it to bear continually against the top of the cylinder. This caused noise, wear and trouble. Adjustment of the crosshead shoes soon put this matter right.

I would suggest that Messrs. Dixon and Anderson examine the crosshead shoes to see that they are correctly adjusted or that the guides are not worn excessively. If the engine and compressor are "built-up" machines, the guide frame should be tested for correct alignment. It appears to be the lifting of the piston which is the cause of the trouble in both cases, and the above explanation is the best one I know of.

JOHN S. LEESE.

Manchester, England.

Water in the Low-Pressure Cylinder

H. R. Low's article in the June 25 issue, relative to this subject, was very instructive. But I would like to inquire if it is general practice to have a fixed cutoff for the low-pressure cylinder of compound engines. If not, I would like Mr. Low to tell us through POWER the receiver pressure and other results, if the governor on the low-pressure cylinder had caused its valve to cutoff early in response to the light load, the same as the high-pressure governor caused its valve to cutoff early.

B. COESRIB.

Detroit, Mich.

[F. F. Nickel's letter, page 27, July 2 issue, on the reasons for a fixed cutoff on the low-pressure cylinder of compound engines bears on this question.—EDITOR.]

Centrifugal Pump Troubles

Under this heading in the June 25 issue, F. Webster uses the formula,

$$F = \frac{WV^2}{Rg} \qquad (1)$$

for finding the centrifugal force. This formula is correct, but why not use the shorter one,

$$F = \frac{WRN^2}{35,196} \qquad (2)$$

which gives the same result?

In the letter referred to

$W = \frac{1}{32}$ lb.;

$N = 3600$;

$R = 10$ in. $= \frac{5}{6}$ ft.

Substituting these values in (1) gives;

$$F = \tfrac{1}{32} \times (3.1416 \times \tfrac{5}{6} \times 2 \times 3600 \div 60)^2 \div \tfrac{5}{6} \times 32.16 = 115 \text{ lb.}$$

Substituting in (2) gives;

$$F = \tfrac{1}{32} \times \frac{10 \times 3600^2}{35,196} = 115 \text{ lb.}$$

The last operation is evidently much simpler.

I have seen formula (1) used so frequently in the technical press that it seems as though few were familiar with the shorter one.

E. D. GAGNIER.

Salem, Ohio.

Babbitting a Large Engine Bearing

The job described by J. M. Burns under this heading in the June 25 issue can be done much easier and quicker. By wrapping the shaft with one thickness of strong brown wrapping paper, the different sections of the bearing can be put in place one at a time. They can be heated before placing in position, and, under ordinary circumstances, will retain enough heat to make the babbitt flow properly.

The paper around the shaft prevents chilling the babbitt, and insures a smooth surface. It also gives just about the right allowance for oil room, so that about all the finishing necessary is making the oil grooves, and trimming the edges. I usually wrap some asbestos wick around the shaft at the ends of the bearing while pouring the babbitt, as it helps to hold the paper smooth and prevents the babbitt from running out. The principal advantage of this method is the positive fit of the bearing, as it is cast in the exact position in which it is to run.

A. G. KNIGHT.

Omaha, Neb.

Sudden Contraction Ruptured Boiler

Mr. Rider's question on this subject in the July 2 issue may be explained as follows:

After the water was blown out, the dry boiler cooled so rapidly that the abnormal contraction caused the rupture.

A similar accident occurred in our plant. A boiler tube failed and let the water cut of the boiler in less time than it takes to tell it. The boilers are of the vertical type, with 4-in. tubes, 22 ft. long. The room was so full of steam I could not see where to go for several minutes. After it cleared away we found the fire and ashes blown entirely off the grates out of the arch door, and on the floor. After the boiler had cooled down we found a tube had opened at the seam 31 in. up from the bottom and 50 in. long; it was open flat at the center of the rupture. The crown-sheet was raised up an inch from the top of a few of the middle tubes.

We found water in the bottom of the boiler up to the opening of the tube. We believe that the crown-sheet was so suddenly left exposed to the fierce heat at the top that it warped up and away from the tubes.

A. I. HAIGHT.

Kalamazoo, Mich.

Inquiries of General Interest

All Questions Must be Accompanied by Name and Address—Not for Publication

Constancy of Governor Action

Do the governor rods which control the cutting off of a Corliss engine, stand stationary when the engine is at work?

E. P.

In all reciprocating engines the rotative effort transmitted to the crank is constantly changing, both from variation of pressure acting on the piston and change of angular position of the connecting-rod with respect to the crank, and, although the weight of the flywheel may make the rotation sufficiently uniform for all practical purposes, it is made up of accelerations and retardations during every revolution and the velocity cannot be maintained absolutely uniform throughout a revolution without employing a flywheel of infinite weight. The governor is therefore subjected to constant fluctuations of speed, and the governor rods cannot stand stationary unless there is so much lost motion that they are not moved in obedience to the centrifugal influences which act on the governor.

Advantages of Centrifugal Pumps

What are the advantages of centrifugal over reciprocating pumps, and more especially as boiler feeders?

W. W. D.

The leading advantages of centrifugal pumps are compactness, silent running, durability and superior economy in cost of power, attendance and repairs, and the facility with which they may be adapted to any location where they may be supplied with power direct connected to an electric motor or steam turbine.

As boiler feeders they have the advantage over reciprocating pumps of continuous delivery without shock or hammering, and of producing no excessive pressure on feed mains for any adjustment of feed stop valves or other stoppage of pipe connections.

Placing Elliptical Manholes

Why are elliptical manholes in the cylindrical part of drums and boilers laid out with the length across the shell?

E. L. V.

The stress per square inch which is produced girthwise by a bursting pressure within a cylindrical shell is twice as great as the stress produced longitudinally. Elliptical manhole openings in the cylindrical part of a shell, therefore, should be made with their length across the shell and with narrowest dimension longitudinal with the shell so as to retain the greatest amount of the material of the shell which is capable of girthwise resistance.

Loss of Heat from Throttling

Is any loss of heat sustained by passing steam through a throttle or pressure-reducing valve, and if not, what becomes of the greater amount of heat and higher temperature which the steam had before reduction to lower pressure?

A. B. E.

There is practically no loss of heat. If, after passing through the valve, the steam at the reduced pressure is brought to rest, or to a reduced velocity, the heat employed as energy during expansion to the lower temperature is reconverted into heat which is imparted to the steam as superheat in its new condition, or is employed in evaporation of entrained water carried over from the higher pressure. While there are, therefore, as many heat units per pound in the throttled as in the higher pressure steam, a lesser proportion of this heat is available for power-producing purposes. If the steam were wiredrawn to atmospheric pressure, each pound would contain the same number of heat units as it did before it was throttled, but they would be of no use in a noncondensing engine.

Tremor of Boilers

What causes some boilers to tremble while in use? Is the tremor a serious menace to the safety of the pipe connections, and if so, how can the annoyance be prevented?

J. R.

Tremor of boilers is usually produced by the reaction of intermittent discharges of steam causing main steam pipe lines to recoil at bends and elbows. Some motion thus set up in pipe lines is inevitable and is most likely of occurrence to an annoying extent when a pipe line supplies high-pressure steam to a single engine which has a sharp cutoff, the vibrations often extending not only to the boiler but also to the boiler setting. Connections and fittings are undoubtedly weakened when thus strained, though as a rule they are not seriously damaged.

Tremor of a boiler from vibration of a pipe line may be almost entirely overcome by providing substantial abutments and anchorages at elbows, but these should be so arranged as not to interfere with expansion. The initial recoil can be almost entirely prevented by placing a large enough receiver in the steam pipe near the engine.

Force of a Blow

How many pounds blow will be delivered by a ram for driving bolts out of locomotive frames, the weight of the ram being 62 lb., its speed 400 ft. per min., length of stroke 8 in., diameter of cylinder 6 in. and air or steam pressure 90 lb. per sq.in.?

J. A.

The pressure to which a blow would be equivalent, for instance, as pounds pressure required for removing a bolt from a locomotive frame, cannot be estimated. When one body exerts an impact on another, the body which was first put in motion does not come to rest until the work which was stored up in it has been transmitted in many ways that are incalculable, such as in setting up motion in the body struck, in abrasion, in rebounding in its own path, in developing heat, etc.

Weight of Water

What is the weight of water per cubic foot at ordinary temperatures? What weight and number of gallons per cubic foot are usually assumed in calculations of water supply, and what weight per gallon?

T. W.

The weight of 1 cu.ft. of pure water at

32	deg. F. (freezing point)	= 62.418 lb.
39.1	deg. F. (greatest density)	= 62.425 lb.
62	deg. F. (standard temperature)	= 62.355 lb.
212	deg. F. (boiling point under 1 atmosphere)	= 59.76 lb.

In ordinary calculations it is usual to assume that fresh water weighs 62½ lb. per cu.ft.

An American gallon is equivalent to 231 cu.in., there being 7.480519 gal. per cu,ft., which for purposes of calculations is taken as 7½ gal. per cu.ft. A gallon of fresh water at 62 deg. F. weighs 8.3356 lb. and is usually taken as 8⅓ lb.

Regulation of Wick Oilers

What is the best way to check the flow of oil from a wick oiler?

J. T. M.

By lateral compression of the wick or by removing some of the strands of the wick.

Study Questions

This Week's Questions
Last Week's Answers

(81) What is the temperature of the mixture when 36.71 lb. of condensing water at 50 deg. F. is used per pound of steam at 216 deg. F.?

(82) Neglecting friction and inertia, what work is done in moving a piston 3 ft. in diameter through a distance of 5 ft. in a horizontal cylinder, against atmospheric pressure?

(83) Two shafts are 18 in. apart. The driving shaft runs at 192 r.p.m. and the driven shaft is to run at 240 r.p.m. in the opposite direction. Required the pitch diameters of a pair of gears connecting the two shafts.

(84) How far apart should the ends of 60-ft. steel rails be laid at a temperature of 32 deg. F. so that they will just touch at a temperature of 98 deg. F.?

(85) With the same temperature range as in the last problem what compression stress per square inch would be created if the rails were laid touching when cold?

Answers to the above will appear in the next issue. Answers to last week's questions follow:

(76) The area under shear is an annular one corresponding to the lateral surface of a cylinder the diameter of the bolt and the height of the head, or

$$\pi DL = 3.1416 \times 1\tfrac{1}{2} \times \tfrac{3}{4} = 3.5343 \; sq.in.$$

The shearing stress per sq.in. is, therefore,

$$\frac{12{,}000}{3.5343} = 3395.3 \; lb.$$

(77) The area of an ellipse is found by the formula

$$A = \pi ab$$

where

$\pi = 3.1416$;
a = Half the major axis;
b = Half the minor axis.

Then

$$A = 3.1416 \times 12 \times 8 = 301.5936 \; sq.in.$$

(78) By the relations of similar triangles their bases are proportional to their altitudes. Then the height of the stack is to the length of the rule as the man's distance from the stack is to the distance of the rule from his eye, or

$$x : 12 :: 162 : 18$$

$$x = \frac{12 \times 162}{18} = 108 \; ft.$$

(79) The volume of the cylinder is its cross-sectional area ($0.7854D^2$) multiplied by its length expressed in the same units or

$$(74)^2 \times 0.7854 \times 7\tfrac{1}{2} \times 12 = 387{,}076.5 \; cu.in.$$

or

$$\frac{387{,}076.5}{1728} = 224 \; cu.ft.$$

Then

$$\frac{224}{1670} = 0.134 \; cu.ft.$$

of water required and as 1 lb. of water occupies about 0.16 cu.ft.

$$\frac{0.134}{0.16} = 0.8375 \; lb.$$

(80) The total heat evolved in burning 1 lb. of carbon to CO_2 is 14,500 B.t.u., and in burning it to CO is 4400 B.t.u. Then

$$14{,}500 - 4400 = 10{,}100 \; B.t.u.$$

more heat is realized in burning 1 lb. of carbon to CO_2.

Daly and Doolin

By Danny Hogan

"It's good sound laws we nade previntin' ther loikes of yer, Doolin, from puttin' onsafe b'ilers inter ther control ov ther ign'rant an' unsusphectin' buyer. Now, wait a minut! Considher ther dacint, wholesome laws made by Massyshusetts, Ohio and Detr'it, lavin' be ther other pla-aces, what forced yez fellas ter build betther b'ilers than ye have been buildin'. An' I'm tellin' yer, Doolin, ther credit ov ther matther b'longs t' ther engineerin' soci'ties—not ther b'ilermakers. Thim laws is sphreadin' over ther entoire land, an' in ther long run 'tis iviry state as will adopt thim. An' we did ut, Mister Doolin—we, ther engineers!"

"Thrue fer ye, thrue indade," replied Doolin. "'Twas done by yez engineers; that can be proved by ther mishtakes ye made.

"As a case in p'int, cast yer oiye over ther rule on convex heads that was sthuck in ther U. S. rules—an' copied by Massyshusetts an' ther rist of ther intilligint engineers as is manufacturin' rules. Wan flash ov yer oiye will convince ye no b'ilermaker was iver ashked t' revoise ut.

"Now, listhen, Daly, an' howld yer whisht. Wid a wather-chube b'iler havin' a forty-eight-inch drum an' havin' a tinsile strength ov 60,000 lb., ye'd git a t'ickness a bit over foive-sixteenths fer a head widout a manhole.

"If ye'll sthick that hairless knob av yez inter ther manhole av a noomber six wather-chube b'iler wid a forty-eight-inch drum, ye'll obsarve that ther b'ilermaker was daffy enough, or had gray matther enough, ter put in a head double ther t'ickness ther rules hollers fer.

"Thrue, they had ther rules, an' knowin' ye foolish engineers wuz ign'rant ov rules an' their fal-lacies, ther nee-farious an' aqually ign'rant b'ilermaker seen his dooty an' done ut widout troublin' ter argefy ther matther.

"Av coorse, Daly, ye moight remonsthrate, whim ye put in ther three new wans, over ther woild waste ov mateerial in thim heads, an' save ther ol' man a few paltry dollars. But will ye?

"An' by ther same token, Daly, whin a-are yez engineers iver goin' t' sthop thot divil's own deed ov schrewing down pop safety valves? Thot ice-house slaughter in Massyshusetts an' thot locomotive massacree in San Antonio—Oh, ther black shame ov ut! Thim two woild deeds alone is all ther raysons in ther worruld why ivery engineer—ther blue an' ther gray, ther licensed an' ther unlicensed—should be compilled t' reshtrain their mad desoire ov monkeyin' wid safety valves. Phut is ut timpts thim annyhow, Daly? Is ut a mic-crobe, a disayse, or phut?

"Sthuff this in yer poipe! Whin thim b'ilermakers wroites a buk ov b'iler rules thay'll provoide a pinalty fer tamperin' wid safety valves (if ther offinder isn't killt in ther manetoime) and ther rule will mar-rch soide be soide ov a betther rule for convex an' concave heads.

"Now, run this t'rough yer turboine, phile O'im drivin' up ther bag on ther pump-house b'iler."

Opportunity for Technical Instruction

The Ohio State University offers an exceptional opportunity to secure a two years' course in industrial arts, which with practical experience enables a student to enter without an examination. The course includes in the first year, elementary algebra, plane and solid geometry, trigonometry, mechanical and shop drawing, pattern making, forging, founding, bench work; in the second year, mechanical sketching, descriptive geometry, mechanisms used in machines, machine-tool practice, and elementary physics.

If any of the subjects are known, another may be substituted. This gives two years of good foundation study and practice with personal teaching under experienced and practical men.

The work begins about the middle of September and closes about the middle of June. This gives the student a chance to secure a position during the summer to help pay expenses the next year which can be kept as low as the following: University fees, $30; books and stationery, $15; room, $35; board, $100; laundry, $15; miscellaneous, $20; total, $215.

Anyone wishing to enter this course should write to Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio, state his position and ask for any further information he desires.

What to See in Kansas City

As is natural in a rapidly growing city, many of the power plants in Kansas City are new and most modernly equipped. A few typical plants are illustrated and described in this issue. To the water-works man the pumping stations will be of interest employing, as they do, two types of units: centrifugal pumps driven by compound Corliss engines for the low-head stage, and the standard type of compound- and triple-expansion high-duty units for the high-head stage. The combined light and power plant and pumping station of Kansas City, Kan., at Quindaro is of especial interest as it represents a new type of municipal plant. At the time our article on the water-works was written, the equipment for the light and power plant had not been installed. But the plant will probably be in operation by the time the convention is held and a visit to it should be interesting.

The Missouri River generating station of the Metropolitan Street Railway Co., also described, is also of interest, as it possesses some unusual features of design. Here the visitor will find two types of turbine and a group of reciprocating engines representing the progress made in the design of prime movers during the last decade. The arrangement of the boilers in two tiers, the duplicate system of steam piping and the circulating-water system are other interesting features.

For the man interested in the smaller plant we present two articles. At *The Kansas City Star* plant the direct-current system is employed. Here the most interesting feature is the system of electric drive and control for the printing presses. At the National Biscuit Co. plant alternating current is employed. While this plant contains nothing particularly unusual in its design or equipment, the feature which makes it worthy of a visit is its exceedingly clean, well kept condition and the ideal arrangement from the standpoint of physical comfort for the operating force.

Numerous other plants throughout the city deserve a visit from interested people and only lack of space prevents us from publishing articles concerning them. However, those who attend the convention and wish to visit or secure information about any plant or type of plant in the city may do so by applying to the reception committee or at the POWER booth in the exhibit hall.

No article on Kansas City is complete unless it contains some reference to her splendid park, parkway and boulevard system of which she is justly proud, and no visit to the city should be concluded until at least a part of the system has been traversed. Over 50 miles of boulevards, parts of which are exceedingly beautiful, connect the 20 or more parks scattered throughout the city. The latter vary in size from one city block to 1350 acres. Perhaps the most noted section of boulevard is the Cliff Drive in North Terrace Park, which winds about a natural ledge under a densely wooded overhanging bluff that overlooks the Missouri River 200 ft. below and the country on the opposite side of the river.

Parkison Patent Furnace

With many grades of coal, especially those of the lignite variety where the moisture, volatile and ash are high, it is difficult to obtain efficient combustion. The Parkison patent furnace, illustrated, is especially designed for use with low-grade fuels.

Its five distinctive features: large ashpit which closes air-tight; individual rocking water-cooled grates; deep firebox accommodating a fuel bed 14 to 24 in. deep; primary air system supplying air to the ashpit under the fuel bed together with the required moisture, usually in the form of exhaust steam from the fan engine, and a secondary air system supplying preheated air over and beyond the fuel bed.

The primary air is obtained from an engine-driven blower, the exhaust from the engine of which is utilized in the ashpit. This air is introduced at a pressure just sufficient to force it through the fuel, which depends largely upon the coarseness of the coal. The draft over the fuel is generally maintained at 0.1 to 0.13 in. water gage. The quantity of the secondary air is regulated by the stack damper and the damper in the supply pipe, as shown. This secondary air is preheated in flowing between the two firebrick arches, as shown.

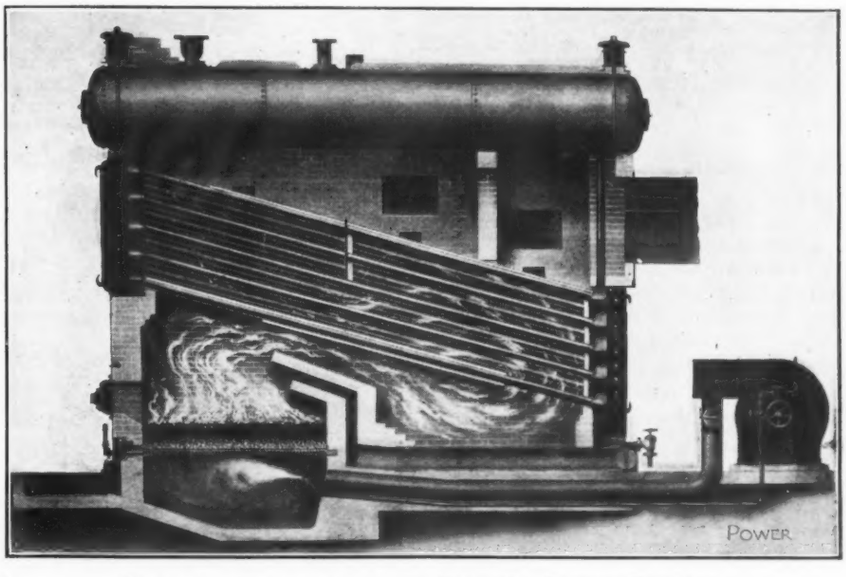
The manufacturers describe the operation of the furnace as follows:

The fuel bed may be considered to be divided into four zones: First, the upper layers of fresh or green fuel from which the volatile matter is being distilled. Second, directly beneath this a bed of fixed carbon burning with insufficient air to produce complete combustion and producing CO. Third, a layer of incandescent fixed carbon burning with sufficient air to produce complete combustion or CO_2. Fourth, a layer of ash or residue. These zones are not defined but blend gradually from the layer of fresh coal at the top to the stratum of clean ash at the bottom. Only enough primary air is admitted to completely burn the fixed carbon in the lower part of the fuel bed. Some of the CO_2 thus formed recombines with the carbon higher up in the fuel bed to form CO which passing upward joins the volatile gases.

The steam admitted to the ashpit, coming in contact with the hot clinkers, serves to soften them so that they may be readily broken up and discharged through the grates. This steam, in passing up through the incandescent fuel bed, is dissociated by the heat into hydrogen and oxygen. These both unite with the carbon, the hydrogen forming water gas, which passes up through the fuel and mingles with the distilled volatile matter in the combustion chamber. Although this water gas does not liberate any more heat in its combustion than was required to cause its formation, it has no derogatory effect.

The secondary and preheated air is admitted to the furnace across the entire width of the arch, as shown, and mingles directly with the combustible gases coming up from the fuel. Under suitable regulation, complete combustion of these gases then takes place rapidly and without the retarding and cooling effect caused by the admission of a supply of cold air.

This furnace is manufactured and installed by the Western Furnace Co., Gas and Electric Building, Denver, Colo.



SECTIONAL ELEVATION OF THE PARKISON PATENT FURNACE

Motor Control Panel

Where motor-driven fire pumps are used the motor and control apparatus must be absolutely reliable.

A fire-pump motor-control panel has been designed for emergency conditions by the General Electric Co., Schenectady, N. Y. All operating parts have bearings of noncorrosive material so that they cannot rust on account of long disuse.

The complete panel is inclosed in a splash-proof case which protects it from water. The panel is mounted on four pipe supports to place it above any accumulation of water in the basement where the panel is generally located.

The pressure governor, connected to the water-pressure system, closes the control circuit of the panel as soon as the water pressure falls to a predetermined value, starting the motor with its starting resistance in circuit. Current limit contactors automatically accelerate the motor by cutting out successive steps of this resistance.

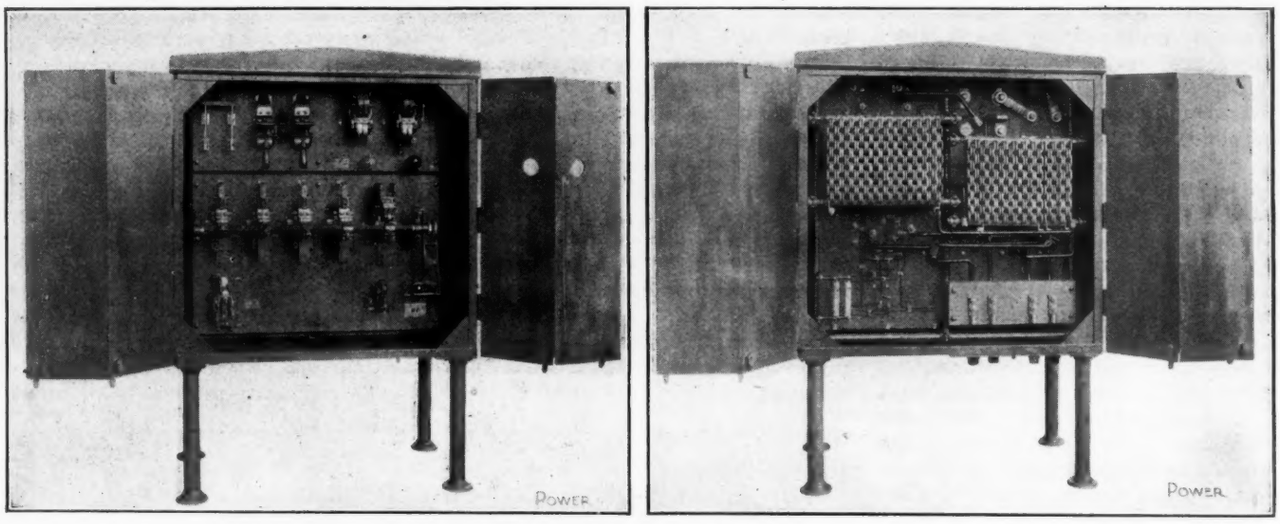
The motor may be started by hand by the operating lever at the right of the contactors. This forces the contactors to close in their proper sequence by a camshaft.

The panel is fully protected against failure of voltage and also from overloading. Two lamps are mounted on the panel, one indicating when there is voltage on the line, the other that the motor is running. The lights are visible through glass bullseyes in the inclosing cover.

The contactors which open the main-line circuit have powerful magnetic blowouts which snuff out the arc when the circuit is opened and prevent burning the contactor parts.

A similar panel has been designed for controlling slip-ring induction motors, where automatic control is obtained by a motor-operated dial switch. The latter may also be operated by hand.

These panels may be used to advantage in hotels, office buildings, stores, etc., for supplementing the city service and insuring sufficient water pressure for everyday use in isolated places where electric power is available.



FRONT AND BACK VIEWS OF AUTOMATIC CONTROL PANEL

Broken Crank Rod Wrecked Engine

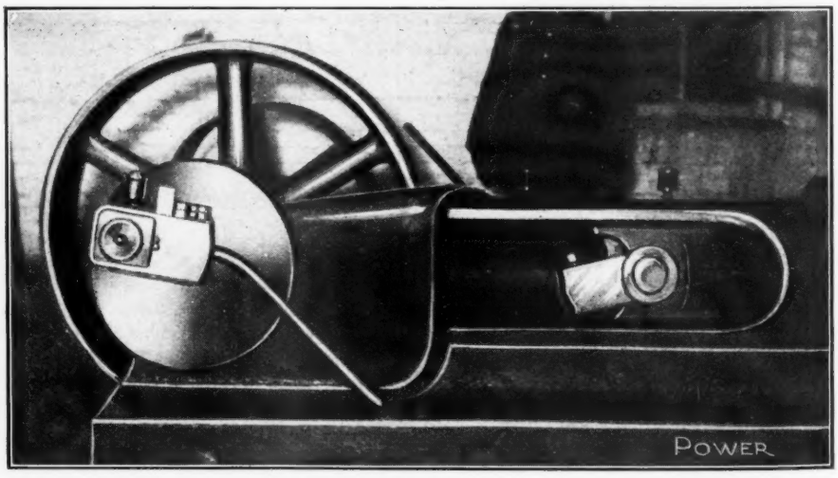
BY C. A. SCOTT

An engine wreck, in which fortunately no one was hurt, was recently witnessed by the writer. It was a 65-hp. slide-valve engine running at 170 r.p.m., and exhausted to the atmosphere. A 48 and 10 by 2-in. balance wheel and a 24x12-in. driving pulley were mounted on a crankshaft extending about 6 ft. to an outboard bearing.

The rod bent close to the crankpin two years ago, but the engine had continued to run about two months each year. Recently a bend was noticed at the crosshead end of the rod which gave the rod the appearance of an elongated letter S made backward. Both bends got worse, and the crosshead end began striking the guide. The engineer chipped away the plate and stopped the pound, but did not like the looks of things and requested the superintendent to shut down and either have the rod straightened or a new and heavier one put on, but the superintendnt could not see his way clear to stop the canning factory.

Next a click developed in the head end of the cylinder which afterward proved to have been caused by a loose nut on the piston rod. Then there was a smash. The superintendent, who stood near the throttle, closed it, and when the steam cleared away the engine was wrecked as the illustration shows.

The rod let go with a clean square break, and as the crank went over dropped down past the guide plate against the frame, doubled up and bent the crankshaft. The piston went through the end of the cylinder as far as the crosshead and guides would let it, stripping off the lower shoe and breaking the cylinder head into scrap. The frame was cracked all around the cylinder end and the engine was practically a complete loss.



ENGINE WRECKED BY BROKEN CRANK ROD

Engineer of Tests Examination

The United States Civil Service Commission announces an examination on Sept. 21 to secure eligibles to fill a vacancy in the position of engineer of tests at $2000 per annum in the Watertown Arsenal, Massachusetts, and vacancies requiring similar qualifications as they may occur. An applicant must be a graduate in civil or mechanical engineering with not less than three years' experience subsequent to graduation. He must also have had experience in metallurgical work, in the making of investigative tests of engineering materials, in the operation of testing machines, and in the interpretation of results.

Competitors will not be assembled for any of the tests, but will be rated according to their training, experience, and original investigations, as shown in application and examination Form 1312, and corroborative evidence. Applicants must furnish the vouchers of two persons able to testify from their personal acquaintance to the fitness of the applicant. It is desirable that these persons belong to the same profession, or are pursuing the same line of work as the applicant. The age limit is 25 years or over. The applicants must be citizens of the United States.

Applicants should at once apply for Form 1312 either to the United States Civil Service Commission, Washington, D. C., or to the secretary of the board of examiners, in their district. No application will be accepted unless properly executed and filed with the commission at Washington prior to the hour of closing business on Sept. 21, 1912.

Merger of Rhode Island Interests

The formal merger of the four electric and gas companies in Pawtucket and Woonsocket, R. I., into the Blackstone Valley Gas & Electric Co. will take place next month. The stockholders of the Pawtucket Gas Co. and the Pawtucket Electric Co. will meet on Sept. 16 to confirm the action of their directors taken on Aug. 16, on selling the property and franchises to the Blackstone Valley Gas & Electric Co. The Woonsocket Gas Co. and the Woonsocket Electric Machine & Power Co. will take similar action on selling out to the $6,000,000 corporation.

Last spring the Stone & Webster interests obtained a charter for the Blackstone Valley Gas & Electric Co.

Lightning Wrecks Switchboard

On Aug. 15, at 2:15 p.m., lightning entered the switch house of the Claremont station of the Claremont Power Co., Claremont, N. H., and nearly demolished the switchboard containing seven generator and eight feeder panels which supplied current to several local industries and the street railway. The four step-down transformers which were used to step down the current from a water-power station 18 miles distant were not injured to any great extent.

The management by unusual activity was able to get the lighting service on the lines and power for the cars before darkness set in. The shops requiring power were partially supplied by 8:20 the following morning.

It is expected that the damage will approach $20,000. This company operates two stations and is one of the largest in New Hampshire.

Largest Single-phase Locomotives

The most powerful single-unit electric locomotives designed up to the present time are being built for a Swiss railway. These locomotives, ten in number, weigh 108 tons each, and have a weight on their ten drivers (adhesive weight) of 85 tons. They are capable of developing 2500 hp. at a speed of 50 miles per hour, with a possible increase of speed to 75 miles per hour, for an uninterrupted run of 1½ hours, and can exert a drawbar pull of 18,000 kg. from the standstill.

The First Power Plant in India

The first steel and iron power plant ever constructed in India, is in Kalimati, 150 miles from Calcutta. This enterprise was projected by a wealthy Parsee, planned by an American engineer from Pittsburgh, and executed by another Pittsburgh man, with the assistance of native labor only. Among the workmen were Bengalis, Punjabis and Sikhs, for whom a town accommodating 25,000 was built in the midst of a jungle. The equipment of the plant includes three horizontal turbo-generators of the Zoelly type, capable of developing some 4000 hp., which is used to drive the machinery of the Tatia Iron & Steel Co.

BOOKS RECEIVED

METHODS OF ORGANIC ANALYSIS. By Henry C. Sherman. The Macmillan Co., New York. Cloth; 407 pages, 5½x8½ in.; illustrated; tables; indexed. Price, $2.40.

MODERN ILLUMINATION THEORY AND PRACTICE. By H. C. Horstmann and V. H. Tousley. F. J. Drake & Co., Chicago, Ill. Flexible leather; 265 pages, 4½x7 in.; illustrated; tables; indexed. Price, $2.

ELECTRICAL METERMAN'S HANDBOOK. Written and compiled by the Committee on Meters, National Electric Light Association, New York. Cloth; 1076 pages, 4½x6½ in.; 730 illustrations; indexed. Price, $3, and to members, $2.

NEW PUBLICATIONS

A SHORT COURSE IN GRAPHIC STATICS. By William Ledyard Cathcart and J. Irvin Chaffee. D. Van Nostrand Co., New York City. Cloth; 183 pages; 5¼x7½ in.; 58 illustrations; tables; indexed. Price, $1.50 net.

In this book the discussion of principles is largely a summary of a previous book on "The Elements of Statics" by the same authors. Some minor additions and different examples appear in the smaller book, which is intended as a brief course in graphic statics for students of mechanical engineering.

The treatment has been limited mainly to the properties and general uses of the force and equilibrium polygons as these are sufficient for the solution of most mechanical problems met with in practice. Some attention has been given to the design of trusses as such constructions as the Warren girder and the walking beam of an engine fall under this classification. The pages devoted to the various subjects under discussion are as follows: Force and equilibrium polygons, 22; stress diagrams for trusses, 18; shears and moments from stationary loads, 32; shears and moments from live loads, 37; center of gravity and moment of inertia, 24; friction, 41. A list of 35 problems to be solved complete the book, which is clear in its treatment and should admirably serve the purposes of a short term course.

DIFFERENTIAL AND INTEGRAL CALCULUS. By Lorrain S. Hulburt. 6x9. pp. 481 + xviii; illus. $2.25, net. Longmans, Green & Co., New York.

Except an engineer use his calculus constantly, the major portion of it is soon forgotten. When needed, it is, of course, most convenient to refer to the book he used in college. If, however, the book he formerly used is lost, and a new one is to be bought, we recommend this volume for consideration.

To the engineer, it is of chief interest to know that apart from following the ordinary lines of an elementary textbook, there is also a short chapter on differential equations and also something on hyperbolic functions. There are many problems on kinematics, although none on dynamics, as that is more particularly the field of a textbook on mechanics. Of course, the geometric subjects of convexity, concavity, flexes, maxima, and minima, are all treated fully. What is also an advantage to the engineer is the omission of many long rigorous proofs; results are there, which are the things needed, why these results should be so under every possible and impossible condition of $f(x, y)$ can be omitted.

While we have written the above from an engineer's standpoint, we believe the book can still be more highly recommended from the teacher's, especially in engineering schools.

THE ELEMENTS OF STRUCTURES. By George A. Hool. McGraw-Hill Book Co., New York City. Cloth; 188 pages, 6x9 in.; 140 illustrations; indexed. Price, $1.75 net.

This book was published early in 1912 and is the first of a series of home study books to be issued by the Extension Division of the University of Wisconsin. Eventually the series will comprise texts on fuels, boilers, steam and gas engines, electricity, refrigeration and other subjects related to the power plant. The books will be produced in cloth-bound volumes and also as assignment pamphlets with loose-leaf binders.

The present work treats only of the general methods to be followed in design, serving as an introduction to all the regular structural engineering studies to follow. It requires an ordinary knowledge of arithmetic, algebra, geometry, logarithms, trigonometry, mechanical drawing, and strength of materials. The space in pages taken by the various chapters is as follows:

General considerations, 3; loads on structures, 23; principles of statics, 22; reactions, 3; shear and moment, 19; influence lines, 7; algebraic treatment of concentrated load systems, 16; graphical treatment of concentrated load systems, 12; stresses in truss members, 10; design of structural members, 10; use of steel handbook, 40; the structural shop, 3; shop drawing, 5. Considering the subjects under discussion the book is simple and direct in treatment. The numerous illustrative problems and study questions will be of great assistance in home study. If the balance of the series are as good as the first book, they should be greatly appreciated by the home student.

SOCIETY NOTE

Meriden Association No. 1, of Meriden, Conn., would like to receive catalogs and literature from all manufacturers of steam power-plant appliances. They will be filed in the association rooms for the use of the members.

In California 135,000 hp. lifts the water to irrigate 300,000 acres.

Michigan N. A. S. E. Convention

The Michigan State Association of the N. A. S. E. opened its eleventh annual convention in the auditorium of the Masonic Temple in Flint at 10:30 a.m., Thursday, Aug. 1, and continued until Saturday, Aug. 3. Mayor C. S. Mott delivered the welcoming address, State President W. E. Fuller, of Kalamazoo, responding. After addresses by members of the Board of Trade and officials of the Michigan Association, President Fuller called the convention to order.

Secretary Galbraith, of the Flint Board of Commerce, was thanked for arranging the automobile tour of the industrial section of Flint when the delegates on Friday visited the plants of the Buick Motor Co., the Champion Ignition Co., the Flint Varnish Works and the Flint Electric Co.'s power house. An entertainment and addresses by men prominent in N. A. S. E. affairs was thoroughly enjoyed.

The officers elected were, president, W. M. Gomley, Grand Rapids; vice-president, A. Miller, Detroit; secretary, E. E. Smith, Kalmazoo; treasurer, Fred Fisch, Flint; conductor, M. Fredericks, Gold Water; doorkeeper, George Maloney; trustee, W. E. Fuller, Battle Creek.

The exhibit of the Central States Exhibitors' Association was held in the basement of the temple and its 36 booth attracted much attention. The exhibitors were:

Lunkenheimer Co., POWER, Garlock Packing Co., Kenneth Anderson Manufacturing Co., American Steam Gauge & Valve Manufacturing Co., H. W. Johns-Manville Co., Osborne Valve & Joint Co., J. D. Swartout, Standard Oil Co., Wickes Boiler Co., Hawk-Eye Compound Co., Greene, Tweed & Co., France Packing Co., Crandall Packing Co., C. E. Squires Co., Buckeye Chemical Co., Garsten Engineering Sales Co., Hills-McCanna Co., V. D. Anderson Co., Keystone Lubricating Co., G. C. Regulator Co., White Star Refining Co., Diamond Power Specialty Co., Jones Underfeed Stoker Co., Crane Co., Anchor Packing Co., Coon-DeWisser Co., Lagonda Manufacturing Co., Dearborn Drug & Chemical Works, *National Engineer*, Schaeffer & Budenberg Manufacturing Co., Home Rubber Co., William Powell Co.

MEMBERS IN ATTENDANCE AT THE FLINT, MICH., N. A. S. E. CONVENTION

OBITUARY

FRANK J. MULCAHY

Frank J. Mulcahy, vice-president and general manager of the Crane Valve Co., Bridgeport, Conn., died, Aug. 19, following an operation for appendicitis. He was 59 years of age and a native of Cleveland, Ohio.

HAROLD GAY

Harold Gay, a well known electrical engineer, died at his home in Farrington, Conn., on Aug. 26.

Mr. Gay gained his first electrical experience at the Schenectady plant of the General Electric Co., and recently was a consulting engineer for L. B. Stillwell & Co., New York City. He also did praiseworthy work in the electrification of the Hoosac Tunnel and the Hudson River tubes.

Mr. Gay's family is prominent in New England history. He is survived by three brothers and three sisters.

PERSONAL

Milton H. Bronsdon, chief engineer of the Rhode Island Co., which operates practically all the street railways in the state, has resigned and will locate at Los Angeles, Calif.

George F. Murphy has been appointed Eastern sales representative of the Busch-Sulzer Brothers-Diesel Engine Co. The Eastern office will be at 30 Church St., New York, as heretofore.

W. J. Snyder, formerly with the E. M. Moore Co., has been appointed Pittsburgh agent of the Foster Engineering Co., Newark, N. J., with office in room 518, Park Building, Pittsburgh, Penn.

Adolph O. Krieger has resigned as publicity manager of the Busch-Sulzer Bros.-Diesel Engine Co., St. Louis, with whom he had been connected for a number of years, to open an office at 916 Victoria Building, St. Louis, for the sale of the Tacchella oil-burning device.